

A Report of the 21st Northeast Regional Stock Assessment Workshop

Assessment of Winter Flounder in Southern New England and the Mid-Atlantic

by

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This report is a product of the 21st Northeast Regional Stock Assessment Workshop (21st SAW). Proceedings and products of the 21st SAW are scheduled to be documented and released as subissues (denoted by a lower case letter) of *Northeast Fisheries Science Center Reference Document* 96-05 (e.g., 96-05a). Tentative titles for the 21st SAW are:

An index-based assessment of winter flounder populations in the Gulf of Maine

Assessment of winter flounder in Southern New England and the Mid-Atlantic

Influence of temperature and depth on the distribution and catches of yellowtail flounder, Atlantic cod, and haddock in the NEFSC bottom trawl survey

Predicting spawning stock biomass for Georges Bank and Gulf of Maine Atlantic cod stocks with research vessel survey data

Preliminary results of a spatial analysis of haddock distribution applying a generalized additive model

Report of the 21st Northeast Regional Stock Assessment Workshop (21st SAW): Public Review Workshop

Report of the 21st Northeast Regional Stock Assessment Workshop (21st SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments

Stock assessment of northern shortfin squid in the Northwest Atlantic during 1993

The Lorenz curve method applied to NEFSC bottom trawl survey data

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INTRODUCTION

Winter flounder (*Pleuronectes americanus*) is a demersal flatfish species commonly found in estuaries and on the continental shelf. The species is distributed between the Gulf of St. Lawrence and North Carolina, although it is not abundant south of Delaware Bay. Winter flounder undergo migrations in and out of coastal estuaries where spawning occurs in the spring of the year. Winter flounder reach a maximum size of around 2.25 kg (5 pounds; Bigelow and Schroeder, 1953) and 65 cm, with the exception of Georges Bank where growth rate is higher and fish may reach a maximum weight up to 3.6 kg (8 pounds).

Current fishery management (described in next section) is controlled by the Atlantic States Marine Fisheries Commission (ASMFC) in state waters and the New England Fishery Management Council in federal waters. Previous assessments have been confined to local populations in state waters and the results were the basis for the current ASMFC Fishery Management Plan (FMP). This report is a joint effort of the Stock Assessment Review Committee's Southern Demersal Subcommittee and the ASMFC Winter Flounder Technical Committee.

Management Summary

Winter flounder fisheries in state waters are managed by Interstate Agreement under the auspices of the Atlantic States Marine Fisheries Commission's FMP for Inshore Stocks of Winter Flounder since approval in May, 1992. The plan includes states from Delaware to Maine, with Delaware granted *de minimus* status (habitat regulations applicable but fishery management not required). The Plan's goal is to rebuild spawning stock abundance and achieve a fishing mortality-based management target of F_{40} (fishing rate that preserves 40% MSP) in three steps - $F_{25\%}$ in 1993, $F_{30\%}$ in 1995, and $F_{40\%}$ in 1999 through implementation of compatible, state-specific regulations.

Coastal states from New Jersey to New Hampshire, inclusive, are currently in compliance with the Plan, having promulgated a broad suite of indirect catch and effort controls. State agencies have set or increased minimum size limits for recreationally and commercially landed flounder (10"-12" and 12", respectively); enacted limited recreational closures and bag limits; and instituted seasonal, areal, or state-wide commercial landings/ gear restrictions. Minimum codend mesh regulations have been promulgated in directed winter flounder fisheries: 5" in NJ and NY, 5.5" in CT, 5" in RI, and 6" in MA. In Massachusetts, several regulations preceded the Plan and, in general, the suite of regulations are the most restrictive.

Winter flounder in the Exclusive Economic Zone are managed under the Northeast Multispecies Fishery FMP developed by the New England Fishery Management Council. This was an appropriate grouping for management purposes because the principal catch of winter flounder occurs as bycatch in directed demersal fisheries for Atlantic cod, haddock, and yellowtail flounder primarily of the northeast EEZ. The management unit encompasses the multispecies finfish fishery that operates from eastern Maine through Southern New England (72°30'). At

least one offshore stock, on Georges Bank, has been identified. The Plan extends authority over vessels permitted under the Plan even while fishing in state waters if federal regulations are more restrictive than the state regulations.

The Multispecies Plan was implemented in September, 1986, imposing a codend minimum mesh size of 5.5" (previously 5.1") in the large-mesh regulatory area of Georges Bank and the offshore portion of Gulf of Maine. There were closed areas and seasons for haddock and yellowtail flounder. In the inner Gulf of Maine, vessels were required to enroll in an Exempted Fisheries Program in order to target small-mesh species such as shrimp, dogfish, or whiting. The by-catch restrictions specified area and season and limited groundfish bycatch to 25% of trip and 10% for the reporting period. In southern New England waters, the groundfish bycatch on vessels fishing with small mesh was constrained but there was a 11" minimum size for winter flounder which corresponded with the length at first capture for 5.5" diamond mesh. Though the Plan was amended four times by 1991, it was widely recognized that many stocks, including winter flounder, were being overfished.

Time-specific stock rebuilding schedules were a part of Amendment #5 which took effect in May, 1994. The rebuilding target for winter flounder, a so-called "large-mesh" species, was $F_{20\%}$ within 10 years. Along with a moratorium on issuance of additional vessel permits, the cornerstone of Amendment #5 was an effort reduction program that required "large-mesh" groundfish vessels to limit days at sea, which would be reduced each year; however, there was an exemption from effort reduction requirements for groundfishing vessels < 45' and for "day boats" (from 2:1 layover day ratio requirement). Dragger retaining more than the "possession limit" of groundfish (10%, by weight, up to 500 lbs) were required to fish with either 5.5" diamond or square mesh in Southern New England or 6" throughout the net in the regulated mesh area of Georges Bank/ Gulf of Maine, respectively. The possession limit was allowed when using small mesh within the inner Gulf of Maine (except Jeffreys Ledge and Stellwagon Bank) and in Southern New England. Those boats fishing in EEZ West of 72° 30' (longitude of Shinnecock Inlet, NY) were required to abide by 5.5" diamond or 6" square codend mesh size restrictions consistent with the Summer Flounder FMP. The minimum landed size of winter flounder was increased to 12" to be consistent with the increased mesh size and to reduce discards. There were many additional rules including time/area closures for sink gillnet vessels, seasonal netting closures of prime fishing areas on Georges Bank (Areas I and II), and on Nantucket Shoals to protect juvenile yellowtail flounder.

At the end of 1994, the Council reacted to collapsed stocks of Atlantic cod, haddock, and yellowtail flounder on Georges Bank by voting a number of emergency actions to tighten existing regulations reducing fishing mortality. Prime fishing areas on Georges Bank (Areas I & II), and the Nantucket Lightship Area were closed. The Council also addressed expected re-direction of fishing effort into Gulf of Maine and Southern New England while, at the same time, developing Amendment # 7 to the FMP. Days-at-sea controls were extended. Currently, any fishing by an EEZ-permitted vessel must be conducted with not less than 6" diamond or square mesh in Southern New England east of 72° 30'. Winter flounder less than 12" in length may not be retained.

STOCK STRUCTURE

Although stock groups consist of an assemblage of adjacent estuarine spawning units, the ASMFC Fishery Management Plan defined three coastal management units based on similar growth, maturity and seasonal movement patterns: Gulf of Maine, Southern New England and the Mid-Atlantic. In the initial phase of the Subcommittee assessment, the criteria for separation of the Southern New England and Mid-Atlantic stock boundaries were reconsidered in light of recent data available since the original stock designations.

Boundaries for four stock units were originally defined in the ASMFC management plan (Howell et al., 1992):

Gulf of Maine: Coastal Maine, New Hampshire, and Massachusetts north of Cape Cod

Southern New England: Coastal Massachusetts east and south of Cape Cod, including Nantucket Sound, Vineyard Sound, Buzzards Bay, Narragansett Bay, Block Island Sound, Rhode Island Sound, Rhode Island coastal ponds and eastern Long Island Sound to the Connecticut River, including Fishers Island Sound, NY.

Mid-Atlantic: Long Island Sound west of the Connecticut River to Montauk Point, NY, including Gardiners and Peconic Bays, coastal Long Island, NY, coastal New Jersey and Delaware.

Georges Bank

The Subcommittee retained a definition of a separate Gulf of Maine complex, based on results of tagging studies, and large differences in growth rates consistent with discrete oceanographic regimes between the Gulf of Maine and Southern New England (Howe and Coates, 1975). Additional analyses of life history characteristics and mixing within the Gulf of Maine may lead to refinement of the complex's definition within the Gulf of Maine.

The Subcommittee combined the Southern New England and Mid-Atlantic units into a single stock complex for assessment purposes. Review of tagging studies (Gibson, 1996b (Appendix IV, this report); Perlmuter, 1947; Saila, 1961; Saila, 1962; Poole, 1969; Howe and Coates, 1975; NUSCo., 1987; Powell, 1989; Crawford, 1990; Black et al., 1988; and Phelan, 1992) indicated that dispersion (and hence mixing) occurs between the previously defined Southern New England and Mid-Atlantic units. The Subcommittee considered that differences in growth and maturity among samples from Southern New England to the Mid-Atlantic reflected discrete sampling along a gradient of changing growth and maturity rates over the range of the stock complex. The group also observed that differences in growth rates within the Mid-Atlantic units were greater than differences between Mid-Atlantic and Southern New England units (Appendix I, Howell, 1996). In offshore areas, the length structure of winter flounder caught in NEFSC research surveys is similar from Southern New England to New Jersey. Most

commercial landings are obtained in these offshore (> 3 mi.) regions, which are not considered in the ASMFC management units (Table 2).

Stock Boundaries and associated Statistical Areas

The Gulf of Maine stock complex extends along the coast of eastern Maine alongshore to Provincetown, MA, corresponding to U. S. Statistical Division 51. Recreational landings from Maine, New Hampshire and northern Massachusetts (northern half of Barnstable County and north to New Hampshire border) are associated with this stock complex.

The Southern New England - Mid-Atlantic winter flounder stock complex extends from the coastal shelf east of Provincetown, MA southward along the Great South Channel (separating Nantucket Shoals and Georges Bank) to the southern geographic limits of winter flounder. Commercial statistical areas within this boundary are 521 and 526, and statistical divisions 53, 61, 62, and 63. The corresponding recreational areas are southern Massachusetts (the southern half of Barnstable County; Dukes, Nantucket and Bristol counties), Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland and Virginia.

The Georges Bank stock extends eastward of the Great South Channel, and covers statistical areas 522, 525, and 551-562.

SOUTHERN NEW ENGLAND - MID-ATLANTIC STOCK COMPLEX

Data Sources

FISHERY DATA

Landings

Total U.S. commercial landings peaked at 11,200 mt in 1981 and have since steadily (Table 1). Landings in 1993 reached a record low of 3,000 mt. 1994 landings by stock area are not currently available. Since 1989, 42% of the commercial landings have been taken from statistical area 521, 13% apiece from areas 526 and 536, and 11% from area 539 (Table 2). The remaining landings (21%) have been obtained from area 538 and divisions 61-62. Most landings have been from the EEZ (86%, 1989-1993 average) with the remainder from state waters. The primary gear is the otter trawl which since 1989 has accounted for 93.7% of the landings. Scallop dredges have accounted for 4.4% with such gears as handlines, pound nets, fyke nets, and gill nets each accounting for less than 1% of total landings.

Recreational landings (Table 3) reached a peak in 1985 of 13.3 million fish (peak weight of 5,772 mt in 1984) but declined thereafter. Landings from 1986 to 1994 averaged 3.7 million fish (1,674 mt) with a record low of 0.8 million fish (393 mt) in 1992. Landings in 1994 from the complex were 1.1 million fish (548 mt). The principal mode of fishing is private/rental boats. With the exception of 1986, 65 - 85% of recreational landings have been taken during January to June.

Discards

Commercial discards for 1985 to 1993 were estimated from length frequency data from NMFS and the Massachusetts Division of Marine Fisheries (MADMF) bottom trawl surveys, commercial port sampling of landings at length, and sea sampling of landings and discard at length. The method follows the approach described by Mayo et al. (1992). Each year was divided into half year periods. Survey length frequency data (MADMF survey in spring and NEFSC in autumn) were smoothed using a three point moving average, then filtered through a mesh selection ogive (Simpson 1989) for 4.5" mesh (1984-1989), 5" mesh (1990-1992, fall 1993) and 5.5" mesh (spring, 1993). The 5.5" mesh selection curve was calculated using the 5" curve adjusted to an L_{50} for 5.5". The choice of mesh sizes was based on those used in the yellowtail assessment for southern New England (Rago et al. 1994) and by comparison to length frequencies of winter flounder in the commercial landings. The mesh filtering process resulted in a survey length frequency of retained winter flounder. A logistic regression was used to model the percent discarded at length from sea sampling data (Figures 1-2), and the resulting percentages at length were applied to the survey numbers at length data to produce the survey-based equivalent of commercial kept and discarded winter flounder. The survey numbers per tow at length "kept" were then regressed against commercial (weighout) numbers landed at length (Table 4). The linear relationship was calculated for those lengths common to both length frequencies and fitted with an intercept of zero. The slope of the regression provided a conversion factor to re-scale the survey "discard" numbers per tow at length to equivalent commercial numbers at length. The resulting vector of number of fish discarded at length was multiplied by a discard mortality rate of 50% (as averaged in Howell et al., 1992) to produce the vector of fish discarded dead at length (commercial) per half year. The number of discards (dead) at length was adjusted by the ratio of weighout landings to total commercial landings and summed across seasons and lengths to produce the annual total number of commercial discards.

Total commercial discards (number) ranged from 11% (1987) to 21% (1989) of the annual catch of winter flounder between 1985 and 1993 (Table 5). An average of 13.0% of the commercial catch (number) was discarded per year. In absolute numbers, discards ranged from a low of 1.6 million fish in 1993 to a high of 5.8 million fish in 1989. Weight of discards ranged from 1,534 mt in 1985 to a low of 457 mt in 1993. There did not appear to be any trend in the proportion discarded.

A discard mortality of 15% was assumed for recreational discards (B2 category from MRFSS data), as assumed in Howell et al., 1992. Recreational discards peaked in 1984-1985 at 0.7 million fish (Tables 3 and 5). Discards have since declined reaching a low in 1992 of 83,000 fish. In 1994, 121,271 fish were estimated to have been discarded. If recreational discards are assumed to have the same average weight per fish as spring commercial discards, the total weight of recreational discards ranged from 15 mt in 1992 to a high of 230 mt in 1985.

Total Catch

Estimates of the total catch of winter flounder during 1985-1993 are given in Table 5. These estimates include commercial and recreational landings and discards. The total catch during this period varied from a high of over 14,000 mt in 1985 to a low of 4,041 mt in 1993. The total catch has declined continuously since 1985.

Sampling Intensity

Length samples of winter flounder are available from both commercial and recreational landings. In the commercial fishery, annual sampling intensity varied from 96 to 224 mt landed per 100 lengths measured. With the exception of 1984, sampling rates exceeded the informal criterion of 100 lengths sampled per 200 mt (Table 6).

In the recreational fishery, sampling intensity varied from 36 to 231 mt per 100 lengths. With the exception of 1985 and 1987, all years exceeded the minimum level of sampling (Table 7).

Age Compositions

Numbers at age were estimated for 1985-1993 for commercial landings, recreational landings, commercial discards and recreational discards. Quarterly commercial age-length samples were applied to corresponding commercial landings at length, with the exception of winter flounder in the unclassified market category. Unclassified landings (annual average of 23% of total landings) and landings not represented in the weighout database (annual average of 6% of total landings) were assumed to have the same age composition as the initial weighout commercial landings at age (Table 8). Landings at lengths with no associated age data within the quarter were assigned ages based on age at length from adjacent quarters. Commercial discard at length was converted to discard at age by half year periods using NEFSC survey age-length keys.

A comparison was undertaken of ageing data collected from inshore regions (where the recreational fishery is prosecuted), to determine if all age data were comparable within the stock complex. Data for ages 3-5 from New Jersey, Connecticut, Massachusetts and NEFSC were compared for 1993-1994. Distributions of length at age from New Jersey and Connecticut were similar, while distributions of length at age from Massachusetts lacked smaller fish at age. Details of the analysis are presented in Appendix I (p.58).

Recreational landings at length were estimated seasonally and geographically. Spring landings were divided into 2 regions; 1) Massachusetts and Rhode Island and 2) Connecticut and south. MADMF survey age-length keys were applied to MA-RI data while CTDEP age-length keys were applied to CT-south data, with the exception of 1993 for which a combined NJ/CT age-length key was used. Age composition of fall recreational data was developed using the

NEFSC autumn survey age-length keys for all areas combined. Recreational discard age data were developed using state survey age data (Appendix II, p. 65).

About 90-94% of commercial landings (in numbers) between 1985-1993 were comprised of fish aged 2-4, with the contribution of age 2 fish declining in the 1990's compared to the mid-1980's (Table 8). Commercial discards were predominately fish aged 2-3. Between 55-85% (average = 74%) of recreational landings were composed of fish aged 2-4 from 1985-1993, with proportionately more fish contributed by ages 5-6 compared to the commercial fishery. Recreational discards were predominately age 2 with some age 1 and age 3 fish. No conspicuous year classes were observed in the total catch at age matrix.

Mean Weight at Age

Mean weights at age were determined for the landings and discards in the commercial and recreational fisheries (Table 9). Length frequencies (cm) for each component were converted to weight (kg) using length-weight equations derived from NEFSC survey samples:

$$\begin{aligned}\text{Spring surveys: } wt &= 0.00001911 * \text{length}^{3.1087} \\ \text{Fall surveys: } wt &= 0.00001826 * \text{length}^{3.1091}\end{aligned}$$

The equations from the spring and fall surveys were applied to catches during the corresponding time periods. The annual mean weights at age from the commercial and recreational fisheries were used in the virtual population analysis and yield per recruit calculations.

Stock Abundance and Biomass Indices

Fishery-Dependent Indices

Commercial LPUE

A general linear model (GLM, SAS 1985) of commercial landings per unit effort (LPUE) was used to develop a standardized index of winter flounder abundance. Landings of winter flounder per day fished were calculated from interviewed trips which landed winter flounder, as recorded in the Northeast Region commercial weighout data base from 1982-1993. The GLM included effects of year, quarter, depth, division, and ton class with 1993, quarter 3, depth ≤ 30 fathoms, division 62 and ton class 3 serving as the standard cell. The model explained 20% of the variance in observed LPUE over the period.

The LPUE indices for 1982-1993 are presented in Figure 3 and indicate a relatively rapid decline in the landings rate from 1982-1988. Since 1988, the landings rate and abundance index have remained relatively stable at low levels.

Recreational LPUE

As an index of winter flounder abundance, mean recreational landings per angler per trip from 1981-1994 was calculated. LPUE declined steadily from a high of 6.69 fish per angler per trip in 1982 to 3.16 fish per angler per trip in 1994 (Figure 4). However, increasing state management restrictions, such as bag limits, has likely affected the catch rate over this period.

Fishery-Independent Indices

State and federal surveys were evaluated as fishery independent indices of winter flounder abundance and biomass. Survey methods (with the exception of Rhode Island and the young-of-year surveys) are reviewed in the proceedings of a 1989 trawl survey workshop sponsored by the ASMFC (Azarovitz et al., 1989).

NEFSC

Mean number-per-tow and weight-per-tow indices were determined from autumn (1963-1995) and spring (1968-1995) NEFSC bottom trawl surveys. Indices from the spring and autumn surveys were based on tows in offshore strata 1-12, 25, 69-76 and inshore strata 1-29, and 45-56. Spring indices prior to 1973 and fall indices prior to 1972 do not include inshore strata. In addition, offshore surveys from 1963-1966 were not conducted south of Hudson Canyon.

Mean weight-per-tow and number-per-tow indices for the spring and autumn time series are presented in Table 10. Although the indices exhibit considerable year-to-year variability, both surveys follow a trend similar to commercial landings. Indices dropped from the beginning of the time series to a low point in the early to mid- 1970's then rose to a peak in the early 1980's. Following several years of high indices, abundance once again declined to below the low levels of the 1970's. After reaching near- or record low levels for the time series in the late 1980's-1990's, indices in the spring and autumn 1995 survey have only increased slightly.

Massachusetts

The Massachusetts Division of Marine Fisheries (MADMF) spring survey from 1978-1994 was used to characterize abundance of winter flounder. Survey areas from east and south of Cape Cod were used in the analysis. The MADMF mean number-per-tow indices steadily declined from a high value of 56.39 in 1983 to a low of 10.57 in 1992 (Table 11). Indices in 1994 have shown an increase to 48.43 fish per tow.

In addition, the MADMF conducts an annual juvenile winter flounder seine survey during June. The survey has been conducted since 1975 in coastal ponds and estuaries. The index has shown a general decline in production, with a high of 0.6 fish per haul in 1977 to a low of 0.05 fish per haul in 1995 (Table 12). Generally there have been lower levels of production in recent years.

Rhode Island

The Rhode Island Division of Fish, Wildlife and Estuarine Resources (RIDFW) has conducted a spring and autumn survey since 1979 based on a stratified random sampling design. Three major fishing grounds are considered in the spatial stratification, including Narragansett Bay, Rhode Island Sound and Block Island Sound.

Survey results are expressed as unweighted arithmetic mean number per tow (Table 11). Indices from 1979-1995 have shown a steady decline from a high value of 130.2 fish per tow in 1979 to a low of 8.22 fish per tow in 1993. Recent indices have shown an increase to 32.47 fish per tow.

The autumn survey, conducted since 1978, provides an index of young-of-year winter flounder. The index shows a great deal of annual variability, although in recent years there have been consistently low levels of recruitment.

Connecticut

The Connecticut Department of Environmental Protection (CTDEP) trawl survey program was initiated in May 1984 and encompasses both New York and Connecticut waters of Long Island Sound. Spring indices of mean number per tow were used as indices of winter flounder abundance (Table 11). CTDEP indices experienced several years of high values between 1988 and 1991, peaking at 223.0 fish per tow in 1990. Index values in 1995 declined to 48.1.

New York

The New York Department of Environmental Conservation (NYDEC) has conducted a small-mesh trawl survey in Peconic Bay since 1985. Winter flounder indices for ages 0 and 1 were evaluated for trends in winter flounder abundance (Table 11). Young of the year indices (age 0; Table 12) have increased in recent years from 0.7 in 1985 to the 1994 index of 2.4. The 1992 index indicated a large year class with an index of 11.4. The corresponding age 1 indices also indicated an increasing abundance with a strong 1992 year class (Table 14).

New Jersey

The New Jersey Department of Environmental Protection (NJDEP) have conducted a bottom trawl survey in coastal waters since 1988. Surveys are conducted bi-monthly from April to January, although the time sequence has undergone some modifications since 1988. Survey indices (Table 11), exemplified as mean number per tow in April, tended to decline between 1988 and 1994, but markedly increased in 1995.

Delaware

The Delaware Division of Fish and Game conducts monthly surveys from April to October using a 16 ft. semi-balloon otter trawl with a 0.5 inch stretch mesh liner. An index of young-of-year winter flounder was developed from stations sampled within Indian River and Rehoboth Bays. The re-transformed annual geometric means, presented in Table 12, indicate variable annual recruitment with a large year class in 1990. The 1994 index indicates above average recruitment.

Coherence among surveys

The surveys conducted by NEFSC and several states have each produced indices of winter flounder abundance. Since each of these surveys sample distinct geographical regions, it is possible that they provide indices for different components of the stock. The coherence among surveys was examined and results are presented in Appendix III (p. 73). The surveys all indicate declining trends in abundance, although performance of individual surveys in terms of tracking year class strength varies because of interannual differences in availability.

Mortality and Stock Size Estimates

Natural Mortality

Instantaneous natural mortality (M) for winter flounder was assumed to be 0.20 and constant across ages. (This represents a lower estimate of M than in previous ASMFC assessments). Commercial catch at age included fish to age 13, under conditions of relatively high fishing mortality. If $M=0.25$, less than 5% of the population would reach age 12 under conditions of no fishing mortality. Therefore, the Subcommittee felt an $M=0.2$, which represents a maximum age of 15, was more representative of the stock complex throughout its range.

Total Mortality

Total mortality in two components of the stock were evaluated using recent tag and recapture data (Table 13). Northeast Utilities Co. marked and recaptured winter flounder in Long Island Sound from 1983 to 1994 and the RIDFW conducted winter flounder tagging in Narragansett Bay from 1986 to 1990. Mortality estimates were made using a Brownie model of survivorship (Brownie et al. 1985). Average estimates of fishing mortality for Long Island Sound averaged 0.72 for 1984-1988 and 0.99 for 1989-1993 (dropping the negative mortality estimate of 1991 from the mean). Narragansett Bay estimates of fishing mortality ranged from 0.81 to 1.92 and averaged 1.19 from 1986 to 1989.

Virtual Population Analysis

Tuning

Total catch at age was calibrated using ADAPT (Conser and Powers 1990) with abundance at age indices (Table 14) from several bottom trawl surveys: NEFSC spring bottom trawl ages 1-7+, NEFSC autumn ages 1-4 (advanced to tune January 1 abundance of ages 2-5), Massachusetts spring ages 1-7+, Rhode Island autumn age 0 (advanced to tune age 1), Rhode Island spring ages 1-7+, Connecticut spring ages 1-7+, New York ages 0-1, Massachusetts summer seine index of age-0 (advanced to tune age 1), and Delaware juvenile trawl survey age-0 (advanced to tune age 1). NEFSC autumn survey catch of ages 5+ were not used because there was little contrast in this series and poor correspondence with other indices. New Jersey trawl survey indices were excluded from calibration because the series began in 1992, although the survey may be useful in future assessments. New York indices were excluded from the final calibration because residuals in preliminary ADAPT runs were strongly trended and the survey covers a small geographic range. Estimated F varied little for eight alternative calibrations, which suggests that final results (Table 15) are stable and relatively robust to choice of tuning indices.

Parameter estimates in the final calibration were moderately precise (initial coefficients of variation ranged from 0.22 to 0.37) and were not significantly correlated. There were, however, some patterns in residuals. Nearly all surveys had years in which all observations deviated from predicted values in the same direction. For example, in 1987, all seven NEFSC spring residuals were negative. Similar residual patterns existed for NEFSC autumn 1993, Massachusetts 1991, and 1994; Rhode Island 1986, 1987, 1991-1994; and Connecticut 1985, 1986, and 1989-1991. As illustrated by a priori analyses of tuning indices, there are strong year effects in survey indices, due to annual distribution patterns or local recruitment events. However, in concert, the surveys appear to provide geographically balanced tuning. Although Connecticut age 1 residuals showed a negative trend over time, the index was included in the final calibration because it represented the Long Island Sound component of the stock complex. There was one extreme residual, NEFSC autumn age 4 in 1987, but there was no extrinsic justification for excluding the observation from the analysis.

Exploitation Pattern

The **exploitation** pattern has been somewhat variable from year to year, but age 4 fish have been **over 90%** recruited since 1986. An average exploitation pattern was calculated as the ratio of the **geometric** mean fishing mortality rates at ages 1-3 to the geometric mean of the fishing mortality rates at age 4-6. The resulting pattern indicates, on average, 0.5% recruitment at age 1, 19% at age 2 and 74% at age 3, from years 1992-1993, to reflect potential effects of recent changes in management measures. For purposes of yield-per-recruit calculations and catch and stock biomass projections, full (100%) recruitment was assumed at ages 4 and older.

Fishing Mortality

Fishing mortality averaged over ages 4-5 has fluctuated without trend between 0.57 and 1.38 since 1985 and has averaged 1.07. Mean F in 1993 was 0.83 (Figure 5).

Spawning Stock Biomass

With maturity as estimated in O'Brien et al. (1993), spawning stock biomass has steadily declined over the period 1985 to 1993. Estimated spawning stock biomasses in 1992 and 1993 were 4,000 and 3,800 mt, respectively, the lowest in the time series, and about 60% less than in 1985 (Figure 6).

Recruitment

Recruitment estimates, at age 1 winter flounder, have followed a steady downward trend, from 35 million fish in 1985 to 11 million fish in 1994 (1993 year class) (Figure 6). The 1994 year class, was estimated to be about 11.5 million fish. The sole exception to the declining recruitment trend is the 1992 year class, with 39 million recruits at age 1 in 1993. Historical young-of-the year survey indices indicate year classes this size or larger occurred prior to 1985 (Tables 12).

Precision of F and SSB estimates

The precision of the 1993 F and SSB estimates from VPA was evaluated using bootstrap techniques (Efron 1982). Two hundred bootstrap iterations were performed in which errors (differences between predicted and observed survey values) were resampled. Estimates of precision and bias are presented in Table 16. Bootstrapped estimates of spawning stock biomass indicate a CV of 9%, with low bias (bootstrap mean estimate of spawning stock biomass of 3,728 mt compared with VPA estimate of 3,792 mt). There is an 80% probability that spawning stock biomass in 1993 was between 3,700 mt and 4,600 mt (Figure 7).

The bootstrap estimates of standard error associated with fishing mortality rates indicate high precision. Coefficients of variation for bias-corrected F estimates ranged from 16% at age 4 to 25% at age 6. There is an 80% probability that F in 1993 was between 0.72 and 1.00 (Figure 8).

Projections

Stochastic projections were based on 200 bootstrapped realizations of numbers at age in 1994. Weights at age in the landings were estimated as the weighted (by number landed) geometric mean weights at age in 1992-1993, to reflect any effects of increased minimum fish sizes. Percentage discarded was similarly estimated as the mean of percentages from 1992-1993. Recruitment was primarily treated deterministically: a Shepherd stock recruitment curve was fitted to all points excluding the 1992 year class (Figure 9). At random, but in about 9 cases of

10, recruitment was generated from the stock-recruitment curve, but a recruitment of 39 million fish at age 1 was allowed randomly in about 10% of the cases.

Under the status quo (1993) level of fishing mortality ($F=0.83$, Figure 10), median spawning stock biomass would be expected to increase during 1995 as the 1992 year class recruited to the spawning stock, decline slightly during 1996-1997, and reach about 8,000 mt in 1999-2000, well below 1984 levels. Landings would similarly increase in 1995, decline during 1996 and 1997 and stabilize around 6,000 mt in 1999-2000 (Figure 11).

If fishing mortality rates were reduced to $F_{0.1}$ ($F=0.22$) in 1996 and maintained at $F_{0.1}$ thereafter (Figure 10), median spawning stock biomass would increase continuously, exceeding 1984 levels by 1997. Landings in 1996 would decline to 2,000 mt (70% lower than in 1995) but would thereafter increase, exceeding the 1994 level (4,000 mt) by 1999 (Figure 11).

If fishing mortality was reduced to a lower level ($F=0.1$) during 1996-2000 (Figure 10), median spawning stock biomass would markedly increase beginning in 1997. Landings in 1996 would decline to only 1,000 mt but increase to 3,000 mt by the year 2000 (Figure 11).

Biological Reference Points

Yield and Spawning Stock Biomass per Recruit

Biological reference points were calculated using the Thompson-Bell yield per recruit model (Thompson and Bell, 1934). Input parameters are summarized in Table 17. Natural mortality was assumed constant at 0.2. The partial recruitment at age was determined from the 1992-1993 exploitation pattern in the VPA. The proportion mature was based on the maturity ogive from O'Brien et al., 1993 (MA DMF spring survey). These proportions were intermediate among survey data from New Jersey, Connecticut, New York, Massachusetts, and NEFSC. Average stock weight was based on the geometric mean weight at age from 1992-1993 from the total catch. Due to low sample sizes among older ages, a curve was fitted to the data set and the fitted mean weights at age were used for ages 7 and greater. The average catch weight was the geometric mean weight at age of the catch for the period 1992-1993, with fitted mean weights used for ages 7 and greater. The proportion of the fishing and natural mortality assumed to occur prior to spawning was equal to 20% of the annual total. The model was applied using a maximum age of 15.

The calculated fishing mortality corresponding to maximum yield per recruit (F_{max}) was 0.536 and $F_{0.1}$ was 0.217 (Table 17). At F_{max} , 16.9% of the maximum spawning potential is achieved. The $F_{40\%}$ target defined in the ASMFC FMP occurs at an F equal to 0.207. At the 1993 F of 0.83, the spawning stock biomass per recruit is less than 11% of the maximum (Figure 12).

Conclusions

The winter flounder complex in the Southern New England - Mid-Atlantic region is over-exploited and at record low levels of spawning stock biomass. Recent recruitment, except for the 1992 year class, has been poor. Significant rebuilding opportunities will be foregone unless fishing mortality is reduced.

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Table 1. Winter flounder commercial landings (metric tons) 1964 - 1993 for Southern New England/Mid-Atlantic stock complex area (U.S. statistical reporting areas 521, 526, divisions 53, 61-63) as reported by NEFSC weighout, state bulletin and general canvas data.

Year	Metric Tons
1964	7,474
1965	8,678
1966	11,977
1967	9,478
1968	7,070
1969	8,107
1970	8,603
1971	7,367
1972	5,190
1973	5,573
1974	4,259
1975	3,982
1976	3,265
1977	4,413
1978	6,327
1979	6,543
1980	10,627
1981	11,176
1982	9,438
1983	8,659
1984	8,882
1985	7,052
1986	4,929
1987	5,172
1988	4,312
1989	3,670
1990	4,232
1991	4,823
1992	3,816
1993	3,010

Table 2. Distribution of commercial landings (percentage of annual total) of winter flounder from Southern New England/Mid-Atlantic stock complex area by U.S. statistical reporting area and distance from shore, 1989-1993.

Year	Area								
	521	526	537	538	539	611	612	613	614-622
1989	33.2	10.8	18.9	7.0	12.1	7.1	5.5	4.2	1.2
1990	45.2	16.8	6.1	4.9	9.5	11.1	4.1	2.0	0.1
1991	46.4	14.7	10.8	1.7	13.7	5.7	3.6	2.9	0.4
1992	37.0	12.5	17.4	2.4	9.4	10.1	4.5	3.4	3.4
1993	46.6	10.0	10.8	2.4	8.2	7.7	4.2	8.0	2.1
AVG.	41.7	13.0	12.8	3.7	10.6	8.3	4.4	4.1	1.4

Year	Distance from Shore			
	Inland	< 3 miles	3-12 miles	> 12 miles
1989	0.0	16.8	13.6	69.6
1990	0.0	16.9	10.9	72.1
1991	0.0	9.1	16.3	74.5
1992	0.0	14.7	10.9	74.5
1993	0.0	13.9	12.4	73.7
AVG.	0.0	14.3	12.8	72.9

Table 3. Estimated number (000's) and weight (mt) of winter flounder caught and discarded in recreational fishery, Southern Massachusetts to New Jersey, 1981-1994.

Number (000's)

	Catch A+B1+B2	Landings A+B1	Release B2	15% Release Mortality
1981	11005.7	8089.4	2916.2	437.4
1982	10664.7	8392.2	2272.5	340.9
1983	11010.0	8365.0	2645.0	396.7
1984	17723.3	12756.0	4967.3	745.1
1985	18056.0	13297.4	4758.6	713.8
1986	9368.4	6994.5	2373.9	356.1
1987	9213.2	6900.4	2312.8	346.9
1988	10133.7	7358.4	2775.3	416.3
1989	5917.9	3681.7	2236.2	335.4
1990	3826.6	2486.3	1340.3	201.0
1991	4324.8	2795.0	1529.9	229.5
1992	1360.3	805.6	554.7	83.2
1993	2210.8	1180.3	1030.5	154.6
1994	1883.8	1075.3	808.5	121.3

Landings (A+B1) Metric Tons

1981	3049.5
1982	2457.1
1983	3523.9
1984	5772.0
1985	5197.8
1986	2940.2
1987	3140.7
1988	3423.1
1989	1802.1
1990	1062.6
1991	1214.3
1992	393.1
1993	542.6
1994	548.1

Table 4. Results of linear regressions of number at length from commercial winter flounder landings by season and survey mean #/tow at length (Spring: MADMF survey, Fall: NEFSC survey).

SPRING

	1985	1986	1987	1988	1989	1990	1991	1992	1993
Standard Error of Y Estimate	49753.45	43503.52	40700.68	40971.60	42896.13	18991.13	65506.22	47813.22	11988.18
R Squared	0.93	0.87	0.90	0.76	0.88	0.94	0.73	0.58	0.67
DF	30	25	30	26	24	21	14	15	20
Coefficient	482016.04	392722.74	332715.91	450332.93	379398.33	493964.29	1002218.12	174763.16	1519347.38
Standard Error of Coefficient	16553.13	18914.07	15542.53	31344.39	20969.03	18368.42	102173.28	21027.32	30868.35

FALL

	1985	1986	1987	1988	1989	1990	1991	1992	1993
Standard Error of Y Estimate	104586.13	48916.93	64800.97	47295.78	55013.55	61680.50	77833.65	54452.27	42038.90
R Squared	0.67	0.82	0.78	0.88	0.70	0.75	0.83	0.81	0.94
DF	28	20	17	22	18	25	17	19	19
X Coefficient	3211138.16	5056901.10	6965849.05	4560440.09	10721275.34	6700488.49	5738827.10	3675354.23	8846877.98
Standard Error of Coefficient	274686.46	327156.19	517121.81	259089.62	1004650.61	504141.09	364187.48	247869.16	381224.43

Table 5. Total winter flounder recreational and commercial catch, 1985-1993 for Southern New England/Mid-Atlantic stock in MT and (number (000's)).

Year	Commercial Landings	Commercial Discards	Recreational Landings	Recreational Discards	Total Catch	% Discards
1985	7052 (14,211)	1534 (4,531)	5198 (13,297)	230 (714)	14014 (32,753)	12.6 (16.0)
1986	4929 (9,460)	1273 (4,902)	2940 (6,994)	66 (356)	9208 (21,712)	14.5 (24.2)
1987	5172 (10,524)	950 (3,545)	3141 (6,900)	61 (347)	9324 (21,316)	10.8 (18.3)
1988	4312 (8,377)	904 (3,728)	3423 (7,358)	69 (416)	8708 (19,879)	11.2 (20.9)
1989	3670 (7,888)	1404 (5,761)	1802 (3,682)	49 (335)	6925 (17,666)	21.0 (34.5)
1990	4232 (7,202)	673 (2,567)	1063 (2,486)	31 (201)	5999 (12,456)	11.7 (22.2)
1991	4823 (9,063)	784 (2,701)	1214 (2,795)	51 (229)	6872 (14,788)	12.2 (19.8)
1992	3816 (6,759)	511 (1,811)	393 (806)	15 (83)	4735 (9,459)	11.1 (20.0)
1993	3010 (5,336)	457 (1,580)	543 (1,180)	31 (155)	4041 (8,251)	12.1 (21.1)

Table 6. Sampling intensity of commercial winter flounder fishery by year, quarter and market category for the Southern New England/Mid-Atlantic stock complex.

		PeeWee	Small	Med	Large	Lmnsole	Unc.	Total	Landings MT	MT per 100 lengths
1982	1		689		215					
	2		1144		1125		281			
	3	135	941	878	1256	172	219			
	4	165	442	100	164		116	8042	9438	117
1983	1		102	201	164		272			
	2	401	583	137	691	96	353			
	3	146	285	505	671	116	153			
	4	152	252	201	306		149	5936	8659	146
1984	1				85		274			
	2	270	419		319	200				
	3	119	240		345		153			
	4	275	116	637	389		124	3965	8882	224
1985	1	165	271	530	197		363			
	2	242	591	408	618		255			
	3	726	451	515	581		98			
	4	134	52	210				6407	7052	110
1986	1	190	92	200	195		388			
	2	310	385	299	409		240			
	3	243	522	218	297		171			
	4	159	305	307	190			5120	4929	96
1987	1	64	306	163	343	159				
	2	260	604	200	686	188				
	3	425	358	104	291	22	99			
	4	247	260	203	289			5271	5172	98
1988	1	47	122	101	104		269			
	2	216	221	250	474	104				
	3	251	385	212	269					
	4	186	203	395	299			4208	4312	102
1989	1		192	100	191					
	2	359	423	517	338	123	106			
	3		174	300	215					
	4		76	303	108			3525	3670	104
1990	1		51	101	100					
	2	263	396	501	511					
	3	148	296	407	245	32				
	4	142	177	497	119		102	4088	4232	104
1991	1		125	207	155					
	2	137	229	410	388					
	3	131	239		96	29				
	4	149	210	304	205	44		3058	4823	158
1992	1		78	200	102		102			
	2	139	352	422	362		236			
	3	88	380	206	320	25	64			
	4							3076	3816	124

Table 7. Sampling intensity of recreational winter flounder fishery, Southern New England/Mid-Atlantic stock complex.

Year	Recreational Landings (MT)	Number Lengths	MT per 100 lengths
1981	3050	1725	177
1982	2457	1972	125
1983	3524	2587	136
1984	5772	3123	185
1985	5198	2357	221
1986	2940	2237	131
1987	3141	1360	231
1988	3423	1944	176
1989	1802	2810	64
1990	1063	2548	42
1991	1214	1755	69
1992	393	1083	36
1993	543	1288	42

Table 8. Winter flounder catch at age (number in 000s) for Southern New England/Mid-Atlantic stock complex.

Commercial Landings					Age								
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	27	3936	5688	3052	1014	326	104	32	17	7	5	2	0
1986	0	2122	4187	2206	551	271	84	27	6	3	1	2	0
1987	0	2488	5465	1895	465	122	40	20	14	12	2	0	0
1988	0	2241	3929	1607	412	122	37	24	3	2	1	0	0
1989	0	1542	4057	1747	431	58	34	13	5	1	0	0	0
1990	0	1003	3977	1757	315	95	37	16	0	3	0	0	0
1991	0	1406	4756	2239	447	143	48	16	5	1	1	0	0
1992	0	484	3416	2127	574	111	32	11	3	0	0	0	0
1993	13	885	2516	1377	361	102	71	7	0	0	2	0	1

Commercial Discards					Age								
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	22	1504	2516	442	43	4	0	0	0	0	0	0	0
1986	78	2220	2389	205	10	0	0	0	0	0	0	0	0
1987	11	1600	1755	170	9	0	0	0	0	0	0	0	0
1988	6	887	2540	276	20	0	0	0	0	0	0	0	0
1989	315	2724	2131	555	33	2	1	0	0	0	0	0	0
1990	16	781	1433	322	14	0	1	0	0	0	0	0	0
1991	17	1238	1205	227	12	1	0	0	0	0	0	0	0
1992	15	845	787	150	14	1	0	0	0	0	0	0	0
1993	201	849	467	57	6	0	0	0	0	0	0	0	0

Total Commercial Catch					Age								
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	49	5440	8204	3494	1057	330	104	32	17	7	5	2	0
1986	78	4341	6576	2411	561	271	84	27	6	3	1	2	0
1987	11	4089	7220	2065	474	123	40	20	14	12	2	0	0
1988	6	3127	6468	1883	432	122	37	24	3	2	1	0	0
1989	315	4266	6187	2301	464	60	35	13	5	1	0	0	0
1990	16	1784	5410	2079	328	95	37	16	0	3	0	0	0
1991	17	2644	5962	2465	460	144	49	16	5	1	1	0	0
1992	15	1328	4203	2277	588	112	32	11	3	0	0	0	0
1993	214	1735	2983	1435	367	103	71	7	0	0	2	0	1

Table 8 con't. Winter flounder catch at age (number in 000s) for Southern New England/Mid-Atlantic stock complex.

Recreational Landings

	Age												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	219	1585	4270	2558	1895	1513	878	0	335	44	0	0	0
1986	106	1765	2432	1797	491	171	81	77	51	8	17	0	0
1987	16	926	1736	1023	2229	633	82	115	64	77	0	0	0
1988	21	534	2858	2078	775	857	128	51	37	20	0	0	0
1989	99	739	944	1200	385	161	91	36	16	8	3	1	0
1990	7	189	814	851	439	101	52	20	3	3	0	2	5
1991	13	232	1122	879	399	107	38	0	1	0	3	0	0
1992	3	123	235	303	85	50	7	0	0	0	0	0	0
1993	31	233	321	289	218	54	20	10	4	2	0	0	0

Recreational Discards

	Age												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	9	340	363	2	0	0	0	0	0	0	0	0	0
1986	32	222	93	9	0	0	0	0	0	0	0	0	0
1987	47	254	43	3	1	0	0	0	0	0	0	0	0
1988	57	279	76	3	0	0	0	0	0	0	0	0	0
1989	49	240	45	1	0	0	0	0	0	0	0	0	0
1990	12	136	51	2	0	0	0	0	0	0	0	0	0
1991	22	151	56	0	0	0	0	0	0	0	0	0	0
1992	7	51	19	1	0	0	0	0	0	0	0	0	0
1993	29	95	26	4	0	0	0	0	0	0	0	0	0

Total Recreational Catch

	Age												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	228	1926	4633	2560	1895	1513	878	0	335	44	0	0	0
1986	138	1986	2526	1805	491	171	81	77	51	8	17	0	0
1987	62	1180	1779	1025	2230	633	82	115	64	77	0	0	0
1988	78	814	2934	2081	775	857	128	51	37	20	0	0	0
1989	148	980	988	1202	385	161	91	36	16	8	3	1	0
1990	20	325	865	853	439	101	52	20	3	3	0	2	5
1991	35	383	1179	879	399	107	38	0	1	0	3	0	0
1992	10	174	254	304	85	50	7	0	0	0	0	0	0
1993	60	328	346	293	218	55	20	10	4	2	0	0	0

Table 8 con't. Winter flounder catch at age (number in 000s) for Southern New England/Mid-Atlantic stock complex.

	Total Landings												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	246	5521	9958	5610	2910	1839	982	32	352	52	5	2	0
1986	106	3886	6619	4003	1042	442	165	104	57	10	19	2	0
1987	16	3414	7201	2918	2694	755	122	135	78	89	2	0	0
1988	21	2775	6787	3684	1188	979	165	75	39	22	1	0	0
1989	99	2281	5000	2947	816	220	125	49	21	9	3	1	0
1990	7	1193	4791	2608	754	196	88	36	4	5	0	2	5
1991	13	1638	5879	3117	846	250	87	16	6	1	4	0	0
1992	3	607	3650	2431	659	161	38	11	3	0	0	0	0
1993	44	1118	2836	1666	579	157	91	17	4	2	2	0	1

	Total Discards												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	31	1845	2878	444	43	4	0	0	0	0	0	0	0
1986	110	2441	2483	213	10	0	0	0	0	0	0	0	0
1987	58	1854	1797	173	10	0	0	0	0	0	0	0	0
1988	63	1166	2615	280	20	0	0	0	0	0	0	0	0
1989	364	2965	2175	556	33	2	1	0	0	0	0	0	0
1990	29	917	1484	324	14	0	1	0	0	0	0	0	0
1991	39	1389	1262	227	12	1	0	0	0	0	0	0	0
1992	22	896	806	151	14	1	0	0	0	0	0	0	0
1993	230	945	492	61	6	0	0	0	0	0	0	0	0

	Total Catch												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	277	7366	12836	6054	2953	1843	982	32	352	52	5	2	0
1986	215	6327	9102	4216	1053	442	165	104	57	10	19	2	0
1987	73	5268	8999	3091	2703	755	122	135	78	89	2	0	0
1988	84	3941	9402	3964	1207	979	165	75	39	22	1	0	0
1989	463	5246	7176	3503	849	222	126	49	21	9	3	1	0
1990	36	2109	6275	2931	767	196	89	36	4	5	0	2	5
1991	53	3027	7140	3344	858	251	87	16	6	1	4	0	0
1992	25	1503	4457	2581	674	162	38	11	3	0	0	0	0
1993	274	2062	3329	1728	585	157	91	17	4	2	2	0	1

Table 9. Winter flounder mean weight at age (kg) for Southern New England/Mid-Atlantic stock complex.

COMMERCIAL DISCARDS

	AGE							
	1	2	3	4	5	6	7	8
1985	0.16	0.27	0.37	0.49	0.55	0.97		
1986	0.03	0.17	0.26	0.37	0.59	0.79		
1987	0.03	0.18	0.29	0.38	0.57	0.84		0.99
1988	0.04	0.17	0.25	0.32	0.46	0.90	1.14	
1989	0.02	0.15	0.25	0.35	0.45	0.60	0.58	0.77
1990	0.03	0.12	0.26	0.37	0.51	0.92	0.64	
1991	0.04	0.23	0.27	0.37	0.49	0.70	0.68	0.79
1992	0.03	0.16	0.30	0.39	0.44	0.66		
1993	0.03	0.21	0.32	0.43	0.51	0.71	0.83	

FALL

	AGE						
	1	2	3	4	5	6	7
1985	0.11	0.24	0.31	0.48	0.50		
1986	0.15	0.27	0.33				
1987	0.11	0.26	0.29	0.58	0.71		
1988	0.06	0.21	0.27	0.42	0.65	0.00	0.55
1989	0.13	0.22	0.29	0.35	0.55	0.65	
1990	0.12	0.24	0.27	0.31	0.55		
1991	0.13	0.28	0.33	0.57			
1992	0.11	0.23	0.32	0.40	0.71		
1993	0.17	0.28	0.35	0.32			

COMMERCIAL LANDINGS

	AGE												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	0.24	0.31	0.43	0.59	0.82	0.93	1.27	1.76	1.88	1.66	2.21	2.38	
1986		0.34	0.45	0.59	0.86	1.13	1.30	1.64	1.86	2.13	2.26	2.02	
1987		0.34	0.43	0.66	0.89	1.15	1.58	1.73	1.70	2.01	2.51		
1988		0.35	0.46	0.66	0.83	1.00	1.11	1.36	1.61	1.89	1.49		
1989		0.36	0.45	0.61	0.78	1.14	1.57	1.57	1.90	2.65	2.80	2.80	
1990		0.39	0.47	0.63	0.91	1.17	1.24	1.50	1.99	2.18		1.90	
1991		0.38	0.48	0.60	0.76	1.01	1.32	1.40	1.91	2.72	2.35		
1992		0.40	0.46	0.64	0.84	1.09	1.24	1.74	2.22		2.92		
1993	0.30	0.41	0.50	0.63	0.84	1.07	1.29	1.75			2.02		1.46

Table 9 con't. Winter flounder mean weight at age (kg) for Southern New England/Mid-Atlantic stock complex.

RECREATIONAL SPRING LANDINGS, CT and SOUTH

	AGE												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	0.01	0.09	0.20	0.30	0.36	0.36	0.37	0.00	0.71	1.31			
1986	0.05	0.12	0.22	0.32	0.38	0.48	0.60	0.43	0.73	0.40	2.15		
1987		0.24	0.26	0.32	0.38	0.42	0.56	0.46	0.51	0.97			
1988		0.23	0.26	0.37	0.49	0.44	0.53	0.62	0.84	0.93			
1989	0.02	0.20	0.27	0.37	0.48	0.52	0.54	0.67	0.71	1.13	1.40	2.13	
1990		0.15	0.25	0.35	0.47	0.47	0.59	0.44		1.22			
1991		0.23	0.28	0.36	0.41	0.55	0.60				1.14		2.38
1992		0.19	0.29	0.38	0.57	0.59	0.88						
1993	0.12	0.23	0.28	0.39	0.44	0.50	0.57	0.59	0.67	0.92			

SPRING RECREATIONAL LANDINGS, MA and RI

	AGE												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1985		0.10	0.26	0.42	0.52	0.68							
1986		0.12	0.32	0.50	0.70	0.73	0.97	1.17	0.86				
1987			0.31	0.40	0.54	0.57	0.92	1.07					
1988		0.14	0.33	0.45	0.67		0.59						
1989		0.17	0.37	0.49	0.70	0.78	0.97	0.98	1.13	1.34	1.40		
1990		0.22	0.37	0.49	0.69	0.86	0.73					1.40	1.69
1991		0.12	0.41	0.57	0.73	0.80							
1992		0.34	0.38	0.50	0.66	0.86	0.92						
1993			0.40	0.53	0.59	0.92	1.22	1.22	1.59				

FALL RECREATIONAL LANDINGS, ALL AREAS COMBINED

	AGE									
	1	2	3	4	5	6	7	8	9	10
1985	0.10	0.24	0.42	0.66						
1986	0.15	0.32	0.48	0.90	1.15		0.66			
1987	0.07	0.27	0.42	0.71	0.80	1.01				
1988	0.03	0.13	0.35	0.48	0.81	0.72				2.63
1989	0.12	0.27	0.47	0.60	1.05	0.60				
1990	0.12	0.25	0.30	0.36	0.57		0.82	1.08	1.24	1.76
1991	0.15	0.27	0.44	0.66	0.96		1.46		1.56	
1992	0.05	0.29	0.36	0.54	0.96	1.28	1.56			
1993	0.22	0.29	0.49	0.62		1.11	1.19		1.99	2.36

RECREATIONAL DISCARDS

	AGE					
	1	2	3	4	5	6
1985	0.16	0.27	0.37	0.49	0.55	0.97
1986	0.03	0.17	0.26	0.37	0.59	0.79
1987	0.03	0.18	0.29	0.38	0.57	0.84
1988	0.04	0.17	0.25	0.32	0.46	0.90
1989	0.02	0.15	0.25	0.35	0.45	0.60
1990	0.03	0.12	0.26	0.37	0.51	0.92
1991	0.04	0.23	0.27	0.37	0.49	0.70
1992	0.03	0.16	0.30	0.39	0.44	0.66
1993	0.03	0.21	0.32	0.43	0.51	0.71

Table 10. Winter flounder NEFSC survey index stratified mean number and mean weight (kgs) per tow for the Southern New England- Mid-Atlantic stock complex, strata set (offshore 1-12, 25, 69-76 ; inshore 1-29, 45 - 56).

YEAR	Spring		Fall	
	Number	Weight	Number	Weight
1963			8.554	3.283
1964			13.673	4.894
1965			15.537	4.435
1966			9.843	3.275
1967			9.109	2.745
1968	2.444	0.734	8.106	2.191
1969	5.640	3.414	6.842	1.939
1970	2.729	1.326	5.110	2.376
1971	2.035	0.756	3.862	1.232
1972	1.866	0.656	7.687	3.054
1973	7.459	2.013	2.691	0.776
1974	3.362	1.043	2.032	0.821
1975	1.136	0.354	2.358	0.742
1976	3.085	0.805	2.375	1.251
1977	4.168	1.190	4.722	1.735
1978	6.696	1.758	3.743	1.430
1979	2.965	1.069	10.058	2.606
1980	15.250	3.533	10.471	3.307
1981	18.234	4.762	10.205	3.109
1982	6.986	1.918	4.928	1.683
1983	6.262	2.469	8.757	2.691
1984	5.523	2.072	2.681	0.887
1985	5.360	1.983	2.727	0.991
1986	2.266	0.766	1.538	0.487
1987	1.763	0.568	1.167	0.419
1988	2.126	0.730	1.246	0.530
1989	2.485	0.582	1.435	0.341
1990	1.992	0.472	1.979	0.546
1991	2.473	0.692	1.950	0.708
1992	1.579	0.435	2.963	0.829
1993	0.961	0.219	1.382	0.392
1994	1.510	0.329	4.134	1.482
1995	2.097	0.592	2.248	0.672

NOTE: 1968-1972 spring index does not include inshore strata

1963-1971 fall index does not include inshore strata

Table 11. Winter flounder mean number per tow for annual state surveys.

Year	MADMF spring	RIDFW spring	CTDEP	NYDEC (age 0-1)	NJDEP (April)
1978	51.50				
1979	53.61	130.19			
1980	38.92	68.41			
1981	46.05	98.03			
1982	40.23	41.48			
1983	56.39	62.98			
1984	36.64	45.55	110.76		
1985	38.36	44.13	83.26	2.71	
1986	36.51	49.74	63.73		
1987	37.84	59.53	79.83	2.62	
1988	27.57	34.93	137.63	2.02	
1989	24.42	21.60	148.18	4.72	86.25
1990	25.75	20.36	222.96	4.53	32.59
1991	10.57	32.04	150.28	6.17	51.77
1992	28.69	9.82	61.25	12.54	18.24
1993	46.92	8.22	63.57	10.20	23.39
1994	48.43	10.05	84.59	5.61	17.88
1995		32.47	48.13		49.37

Table 12. State survey indices for young-of-year winter flounder in Southern New England/
Mid-Atlantic stock complex.

	CTDEP	RIDFW	DEL	MADMF	NYDEC
1975				0.30	
1976				0.32	
1977				0.60	
1978				0.34	
1979		29.61		0.49	
1980		1.64		0.40	
1981		8.56		0.32	
1982		10.10		0.37	
1983		1.98		0.23	
1984		3.06		0.32	
1985		5.08		0.34	0.75
1986		7.24	0.17	0.32	
1987		0.63	0.09	0.27	0.97
1988	15.50	0.41	0.02	0.18	0.69
1989	1.90	1.15	0.29	0.42	1.67
1990	2.90	1.01	0.63	0.33	2.73
1991	5.20	1.44	0.03	0.27	2.48
1992	11.90	6.27	0.27	0.29	11.43
1993	5.60	0.16	0.04	0.07	4.66
1994	14.20	0.07	0.31	0.15	2.44
1995	10.10	0.98		0.05	

Table 13. Results of tagging programs for winter flounder conducted in Long Island Sound and Narragansett Bay.

NUSCo. CT (Long Island Sound)

Year	# Tagged	Survival	SE	F
1983	5615			
1984	3973	0.308	0.041	0.977
1985	3350	0.531	0.068	0.432
1986	2887	0.313	0.041	0.962
1987	2463	0.653	0.079	0.226
1988	4106	0.430	0.064	0.643
1989	2589	0.365	0.046	0.808
1990	2135	0.358	0.042	0.828
1991	4067	0.872	0.108	-0.063
1992	2119	0.146	0.023	1.728
1993	830	0.448	0.109	0.603
1994	959			

Rhode Island DFW (Narragansett Bay)

Year	# Tagged	Survival	SE	F
1986	939	0.366	0.054	0.805
1987	2829	0.207	0.031	1.377
1988	1875	0.120	0.024	1.919
1989	814	0.302	0.084	0.997
1990	580			

Table 14. NEFSC and state surveys mean number per tow at age for winter flounder in the Southern New England/Mid-Atlantic stock complex.

	NEFSC Spring		AGE								
	0	1	2	3	4	5	6	7	8	9	10
1985		0.41	1.21	2.16	0.72	0.51	0.20	0.14	0.01		
1986		0.10	0.49	1.14	0.31	0.15	0.05	0.01			0.02
1987		0.14	0.54	0.70	0.28	0.06	0.02		0.01	0.01	
1988		0.09	0.48	0.98	0.37	0.16	0.02	0.02			
1989		0.14	0.94	0.90	0.34	0.11	0.02	0.02	0.01		
1990		0.23	0.49	0.91	0.28	0.05	0.04	0.01			
1991		0.14	0.60	1.23	0.41	0.05	0.02	0.02	0.01		
1992		0.14	0.39	0.62	0.36	0.05	0.02				
1993		0.14	0.36	0.27	0.12	0.07	0.01	0.01			
1994		0.16	0.76	0.43	0.11	0.04	0.02	0.01			
	NEFSC Autumn		AGE								
	0	1	2	3	4	5	6	7	8	9	10
1985		0.16	1.18	0.99	0.30	0.09	0.01				
1986		0.22	0.90	0.36	0.03	0.01		0.01			
1987		0.03	0.64	0.36	0.12	0.02					
1988		0.03	0.29	0.63	0.22	0.04	0.01	0.01			
1989		0.28	0.82	0.26	0.05	0.01	0.01				
1990		0.07	0.88	0.84	0.15	0.01					
1991		0.06	1.02	0.73	0.12	0.01					
1992		0.15	1.74	0.79	0.26	0.03	0.01				
1993		0.42	0.50	0.34	0.08						
1994		0.44	2.22	1.08	-0.30	0.04	0.03				

Table 14 con't. Mean number per tow at age from NEFSC and state surveys for Southern New England-Mid Atlantic winter flounder stock complex.

Connecticut DEP Spring

AGE

	0	1	2	3	4	5	6	7	8	9	10	11
1984		3.45	46.42	27.70	13.17	6.59	1.43	0.46	0.44	0.05	0.01	0.04
1985		4.38	30.75	28.82	14.12	3.10	0.88	0.39	0.17	0.12	0.02	0.01
1986		6.75	26.03	16.73	10.41	2.53	0.68	0.24	0.23	0.10	0.01	0.02
1987		7.04	34.64	21.33	11.50	3.66	0.96	0.30	0.26	0.12	0.01	0.01
1988		15.21	69.95	39.50	9.12	1.81	1.69	0.22	0.04	0.07	0.02	0.00
1989		13.57	77.13	41.59	11.66	2.74	1.09	0.29	0.06	0.03	0.02	0.00
1990		15.91	127.97	63.42	9.40	4.04	1.91	0.22	0.07	0.00	0.02	0.00
1991		9.49	66.33	58.92	10.12	4.36	0.88	0.17	0.00	0.00	0.00	0.01
1992		6.51	31.78	12.88	8.60	1.10	0.33	0.05	0.00	0.00	0.00	0.00
1993		18.73	20.21	15.32	5.06	3.17	0.76	0.16	0.11	0.04	0.01	0.00
1994		9.97	63.49	6.33	2.90	1.19	0.47	0.17	0.05	0.01	0.01	0.00

Rhode Island DFW spring

AGE

	0	1	2	3	4	5	6	7	8	9	10
1979	29.61	52.81	31.04	10.88	2.7	2.27	0.54	0.16	0.08	0.08	0.02
1980	1.64	16.48	33.51	12.88	1.93	1.52	0.27	0.09	0.04	0.04	0.01
1981	8.56	22.42	36.35	18.92	5.3	4.68	1.1	0.34	0.15	0.16	0.05
1982	10.10	8.86	8.55	6.44	3.1	2.85	0.85	0.36	0.15	0.16	0.06
1983	1.98	20.6	17.23	10.37	5.21	4.82	1.51	0.66	0.26	0.27	0.07
1984	3.06	4.11	16.51	11.63	4.33	3.98	1.08	0.41	0.18	0.2	0.06
1985	5.08	5.48	15.21	10.71	3.47	3.01	0.71	0.22	0.11	0.1	0.03
1986	7.24	10.77	14.04	8.81	3.61	3.37	1.01	0.47	0.18	0.19	0.05
1987	0.63	13.75	21.24	13.62	4.45	4.07	1.06	0.36	0.16	0.16	0.03
1988	0.41	6.66	10.3	11.46	3.8	1.23	0.81	0.19	0	0.04	0.03
1989	1.15	5.56	7	5.18	1.66	0.57	0.31	0.07	0.03	0.02	0.05
1990	1.01	4.28	6.04	5.75	2.14	0.74	0.25	0.08	0.02	0	0.05
1991	1.44	5.88	10.13	9.95	2.9	1.11	0.43	0.15	0	0	0.05
1992	6.27	0.92	0.98	0.84	0.57	0.16	0.05	0	0.01	0.01	0.01
1993	0.16	4.85	2.19	0.53	0.27	0.16	0.04	0.01	0.01	0	0
1994	0.07	1.81	4.77	1.66	1.18	0.34	0.16	0.05	0.01	0	0
1995	0.98	4.66	12.73	7.63	4.35	1.38	0.55	0.13	0.06	0	0

Table 14 con't. Mean number per tow at age from NEFSC and state surveys for Southern New England-Mid Atlantic winter flounder stock complex.

New York DEC

AGE

	0	1
1985	0.75	1.96
1986	-	-
1987	0.97	1.65
1988	0.69	1.33
1989	1.67	3.05
1990	2.73	1.8
1991	2.48	3.69
1992	11.43	1.11
1993	4.66	5.54
1994	2.44	3.17

Massachusetts DMF spring

AGE

	0	1	2	3	4	5	6	7	8	9
1978		9.90	9.70	15.71	9.31	3.14	1.09	1.33	0.51	0.81
1979		4.63	12.86	21.03	8.90	2.93	1.00	0.95	0.46	0.85
1980		1.63	8.21	14.48	9.13	3.01	0.96	0.79	0.28	0.43
1981		8.33	8.72	13.15	9.38	3.68	1.16	0.75	0.32	0.56
1982		2.68	6.23	15.98	9.22	3.32	1.00	0.83	0.41	0.56
1983		2.31	15.70	19.47	12.43	3.54	1.08	0.84	0.45	0.57
1984		1.23	6.92	14.12	10.14	2.64	0.72	0.51	0.17	0.19
1985		4.34	9.93	14.26	6.96	1.77	0.52	0.27	0.12	0.19
1986		3.62	8.07	17.42	5.37	1.21	0.35	0.27	0.08	0.12
1987		9.19	8.24	11.50	6.14	1.61	0.47	0.41	0.13	0.15
1988		2.91	7.06	13.71	3.05	0.53	0.15	0.08	0.02	0.06
1989		1.63	4.95	10.90	4.80	1.14	0.31	0.28	0.13	0.28
1990		4.18	10.66	7.60	2.87	0.30	0.02	0.10	0.00	0.02
1991		1.56	2.79	4.68	1.15	0.23	0.12	0.02	0.00	0.02
1992		7.78	7.55	6.68	4.16	1.64	0.59	0.07	0.08	0.14
1993		14.17	17.56	11.70	2.71	0.62	0.14	0.02	0.00	0.00
1994		11.37	16.12	14.65	4.66	0.61	0.58	0.37	0.05	0.02

Table 15. Virtual population analysis of winter flounder in Southern New England - Mid Atlantic stock complex.

INPUT PARAMETERS AND OPTIONS SELECTED

Natural mortality is 0.2 Oldest age (not in the plus group) is 6

For all yrs prior to the terminal year (1993), backcalculated stock sizes for the following ages used to estimate total mortality (Z) for age 6: 4 5 6

This method for estimating F on the oldest age is generally used when a flat-topped partial recruitment curve is thought to be characteristic of the stock.

F for age 7+ is then calculated from the ratio of F[age 7+] to F[age 6]= 1.000

Stock size of the 7+ group is then calculated using the following method: CATCHEQ

Partial recruitment estimate for 1993

1	0.0500
2	0.2000
3	0.5000
4	1.0000
5	1.0000
6	1.0000

Objective function is SUM w*(LOG(OBS) - LOG(PRED))**2

Indices normalized (by dividing by mean observed value) before tuning to VPA stock sizes.

Biomass estimates (other than SSB) reflect mean stock sizes. SSB calculated as in the NEFSC projection program (see note below SSB table for description of the algorithm).

The following indices of abundance are available:

1	NEFSC (RV) SPRING AGE 1	19	MA SPRING AGE 7
2	NEFSC (RV) SPRING AGE 2	20	RI FALL AGE 0
3	NEFSC (RV) SPRING AGE 3	21	RI SPRING AGE 1
4	NEFSC (RV) SPRING AGE 4	22	RI SPRING AGE 2
5	NEFSC (RV) SPRING AGE 5	23	RI SPRING AGE 3
6	NEFSC (RV) SPRING AGE 6	24	RI SPRING AGE 4
7	NEFSC (RV) SPRING AGE 7	25	RI SPRING AGE 5
8	NEFSC (RV) FALL AGE 1	26	RI SPRING AGE 6
9	NEFSC (RV) FALL AGE 2	27	RI SPRING AGE 7
10	NEFSC (RV) FALL AGE 3	28	CT SPRING AGE 1
11	NEFSC (RV) FALL AGE 4	29	CT SPRING AGE 2
13	MA SPRING AGE 1	30	CT SPRING AGE 3
14	MA SPRING AGE 2	31	CT SPRING AGE 4
15	MA SPRING AGE 3	32	CT SPRING AGE 5
16	MA SPRING AGE 4	33	CT SPRING AGE 6
17	MA SPRING AGE 5	34	CT SPRING AGE 7
18	MA SPRING AGE 6	44	MA SEINE AGE 0
		45	DEL SURVEY AGE 0

Obs Indices (before transformation) by index & yr; with index means

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	*****
1	0.410	0.100	0.140	0.090	0.140	0.230	0.140	0.140	0.140	0.160	0.169
2	1.210	0.490	0.540	0.480	0.940	0.490	0.600	0.390	0.360	0.760	0.626
3	2.160	1.140	0.700	0.980	0.900	0.910	1.230	0.620	0.270	0.430	0.934
4	0.720	0.310	0.280	0.370	0.340	0.280	0.410	0.360	0.120	0.110	0.330
5	0.510	0.150	0.060	0.160	0.110	0.050	0.050	0.050	0.070	0.040	0.125
6	0.200	0.050	0.020	0.020	0.020	0.040	0.020	0.020	0.010	0.020	0.042
7	0.150	0.030	0.020	0.020	0.030	0.010	0.030	0.000	0.010	0.010	0.034
8	0.000	0.160	0.220	0.030	0.030	0.280	0.070	0.060	0.150	0.420	0.158
9	0.000	1.180	0.900	0.640	0.290	0.820	0.880	1.020	1.740	0.500	0.886
10	0.000	0.990	0.360	0.360	0.630	0.260	0.840	0.730	0.790	0.340	0.589
11	0.000	0.300	0.030	0.120	0.220	0.050	0.150	0.120	0.260	0.080	0.148
13	4.340	3.620	9.190	2.910	1.630	4.180	1.560	7.780	14.170	11.370	6.075
14	9.930	8.070	8.240	7.060	4.950	10.660	2.790	7.550	17.560	16.120	9.293
15	14.260	17.420	11.500	13.710	10.900	7.600	4.680	6.680	11.700	14.650	11.310
16	6.960	5.370	6.140	3.050	4.800	2.870	1.150	4.160	2.710	4.660	4.187
17	1.770	1.210	1.610	0.530	1.140	0.300	0.230	1.640	0.620	0.610	0.966
18	0.520	0.350	0.470	0.150	0.310	0.020	0.120	0.590	0.140	0.580	0.325
19	0.580	0.470	0.690	0.160	0.690	0.120	0.040	0.290	0.020	0.440	0.350
20	3.060	5.080	7.240	0.630	0.410	1.150	1.010	1.440	6.270	0.160	2.645
21	5.580	10.770	13.750	6.660	5.560	4.280	5.880	0.920	4.850	1.810	6.006
22	15.210	14.040	21.240	10.300	7.000	6.040	10.130	0.980	2.190	4.770	9.190
23	10.710	8.810	13.620	11.460	5.180	5.750	9.950	0.840	0.530	1.660	6.851
24	3.470	3.610	4.450	3.800	1.660	2.140	2.900	0.570	0.270	1.180	2.405
25	3.010	3.370	4.070	1.230	0.570	0.740	1.110	0.160	0.160	0.340	1.476
26	0.710	1.010	1.060	0.810	0.310	0.250	0.430	0.050	0.040	0.160	0.483
27	0.460	0.890	0.710	0.260	0.170	0.150	0.200	0.030	0.020	0.060	0.295

28	4.880	6.750	7.040	15.210	13.570	15.910	9.490	6.510	18.730	9.970	10.806
29	30.750	26.030	34.640	69.950	77.130	127.970	66.330	31.780	20.210	63.490	54.828
30	28.820	16.730	21.330	39.500	41.590	63.420	58.920	12.880	15.320	6.330	30.484
31	14.120	10.410	11.500	9.120	11.660	9.400	10.120	8.600	5.060	2.900	9.289
32	3.100	2.530	3.660	1.810	2.740	4.040	4.360	1.100	3.170	1.190	2.770
33	0.880	0.680	0.960	1.690	1.090	1.910	0.880	0.330	0.760	0.470	0.965
34	0.710	0.600	0.700	0.350	0.400	0.310	0.180	0.050	0.320	0.240	0.386
44	0.318	0.335	0.323	0.274	0.181	0.421	0.325	0.268	0.292	0.066	0.280
45	0.000	0.000	0.170	0.090	0.020	0.290	0.630	0.030	0.270	0.040	0.193

WEIGHTING USED IN THE OBJECTIVE FUNCTION BY INDEX AND YR (omega) = 1.00
 DOWNWEIGHTS BY YEAR (delta) 1985 TO 1994 = 1.00
 ITERATIVE RE-WEIGHTS BY INDEX (chi) = 1.00

CATCH AT AGE (thousands)

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	277	215	73	84	463	36	53	25	274
2	7366	6327	5268	3941	5246	2109	3027	1503	2062
3	12836	9102	8999	9402	7176	6275	7140	4457	3329
4	6054	4216	3091	3964	3503	2931	3344	2581	1728
5	2953	1053	2703	1207	849	767	858	674	585
6	1843	442	755	979	222	196	251	162	157
7	1424	357	426	303	209	141	115	53	116
1+	32753	21712	21316	19879	17667	12456	14788	9454	8251

CAA summary for ages 2-5 3-5 4-5 5-5

	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	29208	20698	20061	18514	16774	12083	14370	9214	7703
3	21843	14371	14793	14573	11528	9974	11343	7712	5641
4	9006	5269	5794	5171	4352	3699	4203	3255	2312
5	2953	1053	2703	1207	849	767	858	674	585

WT AT AGE (MID-YR) in kg.

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.111	0.129	0.046	0.039	0.118	0.082	0.093	0.079	0.169
2	0.282	0.292	0.287	0.279	0.258	0.295	0.317	0.287	0.334
3	0.364	0.398	0.384	0.351	0.378	0.394	0.420	0.427	0.460
4	0.482	0.480	0.551	0.508	0.508	0.525	0.534	0.599	0.592
5	0.522	0.685	0.475	0.634	0.660	0.672	0.603	0.802	0.689
6	0.467	0.879	0.564	0.517	0.716	0.808	0.823	0.945	0.878
7	0.613	0.961	0.853	0.827	1.073	0.990	1.168	1.395	1.167

WT AT AGE (JAN 1) in kg.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0.068	0.086	0.019	0.015	0.075	0.042	0.053	0.038	0.176	0.050
2	0.237	0.180	0.192	0.113	0.100	0.187	0.161	0.163	0.162	0.162
3	0.317	0.335	0.335	0.317	0.325	0.319	0.352	0.368	0.363	0.687
4	0.404	0.418	0.468	0.442	0.422	0.445	0.459	0.502	0.503	0.582
5	0.402	0.575	0.477	0.591	0.579	0.584	0.563	0.654	0.642	0.697
6	0.494	0.677	0.622	0.496	0.674	0.730	0.744	0.755	0.839	0.739
7	0.613	0.961	0.853	0.827	1.073	0.990	1.168	1.395	1.167	1.167

PERCENT MATURE (females)

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	53	53	53	53	53	53	53	53	53
4	95	95	95	95	95	95	95	95	95
5	100	100	100	100	100	100	100	100	100
6	100	100	100	100	100	100	100	100	100
7	100	100	100	100	100	100	100	100	100

SEX RATIO (Percent Female)

	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGES 1-7+	50	50	50	50	50	50	50	50	50

RESULTS

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

SUM OF SQUARES	160.028936			
ORTHOGONALITY OFFSET.....	0.001730			
MEAN SQUARE RESIDUALS	0.531658			
	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.
N 1	1.13863E4	3.36138E3	3.38740E0	0.30
N 2	3.19974E4	7.26557E3	4.40398E0	0.23
N 3	8.17072E3	1.77745E3	4.59688E0	0.22
N 4	3.83582E3	9.78661E2	3.91946E0	0.26
N 5	9.95556E2	3.12932E2	3.18138E0	0.31
N 6	5.15184E2	1.58402E2	3.25237E0	0.31
N 7	1.10696E2	4.14315E1	2.67178E0	0.37
QRV SPR 1	4.07078E-5	9.63515E-6	4.22492E0	0.24
QRV SPR 2	4.58066E-5	1.07319E-5	4.26826E0	0.23
QRV SPR 3	6.45843E-5	1.50762E-5	4.28385E0	0.23
QRV SPR 4	1.60543E-4	3.75108E-5	4.27991E0	0.23
QRV SPR 5	3.94543E-4	9.26076E-5	4.26037E0	0.23
QRV SPR 6	1.03675E-3	2.44153E-4	4.24633E0	0.24
QRV SPR 7	1.62308E-3	4.09160E-4	3.96687E0	0.25
QRV FAL 1	3.56164E-5	8.80646E-6	4.04435E0	0.25
QRV FAL 2	7.21348E-5	1.77640E-5	4.06074E0	0.25
QRV FAL 3	1.76514E-4	4.35130E-5	4.05659E0	0.25
QRV FAL 4	4.96510E-4	1.23018E-4	4.03607E0	0.25
QMA SPR 1	3.48712E-5	8.25369E-6	4.22492E0	0.24
QMA SPR 2	4.36873E-5	1.02354E-5	4.26826E0	0.23
QMA SPR 3	6.95378E-5	1.62325E-5	4.28385E0	0.23
QMA SPR 4	1.64247E-4	3.83764E-5	4.27991E0	0.23
QMA SPR 5	4.54889E-4	1.06772E-4	4.26037E0	0.23
QMA SPR 6	1.12782E-3	2.65600E-4	4.24633E0	0.24
QMA SPR 7	1.79700E-3	4.29208E-4	4.18679E0	0.24
QRI FAL 0	2.49809E-5	5.91275E-6	4.22492E0	0.24
QRI SPR 1	3.56451E-5	8.43687E-6	4.22492E0	0.24
QRI SPR 2	3.62829E-5	8.50062E-6	4.26826E0	0.23
QRI SPR 3	4.86152E-5	1.13485E-5	4.28385E0	0.23
QRI SPR 4	1.37897E-4	3.22197E-5	4.27991E0	0.23
QRI SPR 5	3.23864E-4	7.60178E-5	4.26037E0	0.23
QRI SPR 6	9.90564E-4	2.33276E-4	4.24633E0	0.24
QRI SPR 7	8.76000E-4	2.06296E-4	4.24633E0	0.24
QCT SPR 1	4.09188E-5	9.68510E-6	4.22492E0	0.24
QCT SPR 2	4.21006E-5	9.86363E-6	4.26826E0	0.23
QCT SPR 3	5.98792E-5	1.39779E-5	4.28385E0	0.23
QCT SPR 4	1.68385E-4	3.93432E-5	4.27991E0	0.23
QCT SPR 5	5.09461E-4	1.19581E-4	4.26037E0	0.23
QCT SPR 6	1.39870E-3	3.29391E-4	4.24633E0	0.24
QCT SPR 7	2.32618E-3	5.55600E-4	4.18679E0	0.24
QMA SEI 0	4.08999E-5	9.68063E-6	4.22492E0	0.24
QDEL SV 0	2.77800E-5	7.38940E-6	3.75945E0	0.27

CATCHABILITY ESTIMATES IN ORIGINAL UNITS

	ESTIMATE	STD. ERR.	C.V.
QRV SPR 1	6.87961E-6	1.62834E-6	0.24
QRV SPR 2	2.86749E-5	6.71817E-6	0.23
QRV SPR 3	6.03218E-5	1.40812E-5	0.23
QRV SPR 4	5.29791E-5	1.23786E-5	0.23
QRV SPR 5	4.93179E-5	1.15760E-5	0.23
QRV SPR 6	4.35436E-5	1.02544E-5	0.24
QRV SPR 7	5.59062E-5	1.40933E-5	0.25
QRV FAL 1	5.61948E-6	1.38946E-6	0.25
QRV FAL 2	6.38794E-5	1.57310E-5	0.25
QRV FAL 3	1.03947E-4	2.56243E-5	0.25
QRV FAL 4	7.33731E-5	1.81794E-5	0.25
QMA SPR 1	2.11842E-4	5.01411E-5	0.24
QMA SPR 2	4.05986E-4	9.51174E-5	0.23
QMA SPR 3	7.86472E-4	1.83590E-4	0.23
QMA SPR 4	6.87704E-4	1.60682E-4	0.23
QMA SPR 5	4.39423E-4	1.03142E-4	0.23
QMA SPR 6	3.66543E-4	8.63200E-5	0.24
QMA SPR 7	6.28951E-4	1.50223E-4	0.24
QRI FAL 0	6.60745E-5	1.56392E-5	0.24
QRI SPR 1	2.14085E-4	5.06719E-5	0.24
QRI SPR 2	3.33440E-4	7.81207E-5	0.23
QRI SPR 3	3.33062E-4	7.77483E-5	0.23
QRI SPR 4	3.31643E-4	7.74885E-5	0.23

CORRELATION BETWEEN PARAMETERS ESTIMATED (SYMBOLIC FORM)

SYMBOLS:	=	LARGE NEGATIVE CORRELATION	whenever	$-1 \leq R < -L$
	-	MODERATE NEGATIVE CORRELATION	whenever	$-L \leq R < -M$
	.	SMALL CORRELATION	whenever	$-M \leq R \leq +M$
	+	MODERATE POSITIVE CORRELATION	whenever	$+M < R \leq +L$
	*	LARGE POSITIVE CORRELATION	whenever	$+L < R \leq +1$

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SUMMARY OF STANDARDIZED RESIDUALS

NEFSC SPRING Index is tuned to the sum of Jan1 full stock sizes (in number) for ages 1 to 7, etc.

Year	1	2	3	4	5	6	7
1985	0.7450	0.5283	0.3900	0.4101	1.1101	0.6099	0.2541
1986	-1.1161	-0.6816	0.1583	-0.7948	0.1265	0.0629	-0.6701
1987	-0.3349	-0.4767	-0.5457	-0.0671	-1.8645	-1.4457	-0.9787
1988	-0.9811	-0.3242	-0.0670	0.2080	0.8485	-1.5603	-0.2603
1989	-0.1778	0.5578	0.1076	0.2216	0.7127	0.4185	0.7465
1990	0.9141	-0.1125	0.1911	0.1318	-0.3418	1.4556	-0.3035
1991	0.4588	0.5489	0.5883	0.5809	-0.3178	0.2945	1.6145
1992	0.4182	0.1959	0.2219	0.5928	-0.1393	0.7295	-
1993	-0.9056	0.0327	-0.8574	-0.4415	0.1466	-0.4074	-0.3118
1994	0.9795	-0.2583	-0.1872	-0.8418	-0.2811	-0.1574	-0.0908

Partial variance:

1	2	3	4	5	6	7
0.3569	0.1090	0.1023	0.1514	0.3800	0.4836	0.3340

NEFSC FALL Index is tuned to the sum of Jan1 full stock sizes (in number) (i.e. age 1 index tuned to age 2 catch)

Year	1	2	3	4
1986	0.0184	0.1270	-0.1267	0.5323
1987	0.5270	-0.2796	-0.6468	-3.3600
1988	-1.8915	-0.7300	-0.7539	-0.0909
1989	-1.9313	-1.5242	0.1431	1.1184
1990	1.3552	-0.0303	-0.8941	-0.8866
1991	-0.1625	0.0505	0.6402	0.6441
1992	-0.1460	0.8261	0.6380	0.5165
1993	1.0672	1.6193	1.2187	1.4014
1994	1.1635	-0.0589	-0.2185	0.1247

Partial variance:

1	2	3	4
0.8154	0.4268	0.2844	1.1096

MASS SPRING Index is tuned to the sum of Jan1 full stock sizes (in number): index age 1 to catch age 1.

Year	1	2	3	4	5	6	7
1985	-0.7195	-0.2196	-0.5433	0.0058	-0.1830	-1.0014	-1.2106
1986	-0.8942	-0.4744	0.3760	-0.3991	-0.0098	-0.1901	-0.2159
1987	0.7032	-0.3740	-0.2287	0.6520	-0.3525	-0.0377	0.5581
1988	-0.9141	-0.2719	0.0296	-0.4147	-0.5085	-1.7186	-0.7278
1989	-1.5117	-0.7986	0.0065	0.3368	0.9199	1.2557	1.7273
1990	0.1909	0.4766	-0.4198	-0.1921	-0.8441	-2.4167	-0.2150
1991	-0.9353	-0.9782	-1.1008	-1.5203	-1.2245	-0.1699	-1.3104
1992	1.2279	0.6150	-0.0396	0.4333	1.6480	2.4494	2.2953
1993	0.7264	1.7291	0.7898	0.3179	0.1385	0.2903	-2.6807
1994	2.1264	0.2960	1.1302	0.7804	0.4559	1.5390	1.7796

Partial variance:

1	2	3	4	5	6	7
0.7492	0.3483	0.2284	0.2487	0.3919	1.2018	1.3728

RI FALL Index is tuned to the sum of Jan1 full stock sizes (in number) for age 1

Year	AGE 0
1985	0.3991
1986	1.1683
1987	1.9740
1988	-1.4149
1989	-1.8067
1990	0.0188
1991	0.0663
1992	0.5122
1993	1.2060
1994	-2.1231

Partial variance : 1.0220

RI SPRING Index is tuned to the sum of Jan1 full stock sizes (in number) for ages 1 to catch at age 1.

Year	1	2	3	4	5	6	7
1985	-0.3893	0.6352	0.2425	0.0515	0.4297	-0.9396	-0.6901
1986	0.5866	0.5550	0.6194	0.0565	1.2795	0.8980	1.5693
1987	1.2414	1.1946	1.1818	1.2107	0.8039	0.7123	1.0074
1988	0.2070	0.5160	0.9622	0.8870	0.5307	0.2289	-0.4849
1989	0.1567	-0.0534	0.1646	-0.1192	-0.1462	0.8903	0.9111

1990	0.2089	-0.0325	0.3761	0.4056	0.2387	0.6819	0.8260
1991	0.8700	1.0603	1.1121	0.7484	0.8187	1.2151	1.0100
1992	-1.7145	-1.9152	-1.7049	-1.2925	-1.6592	-1.3009	-1.1568
1993	-0.7584	-0.8559	-2.2758	-1.8448	-1.8347	-1.7932	-1.8991
1994	-0.4083	-1.1040	-0.6779	-0.1031	-0.4612	-0.5927	-1.0931

Partial variance :

1	2	3	4	5	6	7
0.3979	0.5530	0.7682	0.4883	0.5939	0.6188	0.7770

CT SPRING Index is tuned to the sum of Jan1 full stock sizes (in number) for ages to catch at age 1.

Year	1	2	3	4	5	6	7
1985	-1.5678	-1.0529	-0.7331	-0.1509	-1.0145	-2.0676	-1.4215
1986	-1.0489	-1.2518	-0.8342	-0.6182	-0.5984	-1.0670	-0.3693
1987	-0.6715	-0.7881	-0.5361	0.3857	-0.8264	-0.8460	0.0896
1988	0.3448	0.4998	0.3261	-0.0395	-0.4242	-0.1849	-0.1426
1989	0.3856	0.5840	0.6883	0.4270	0.5225	1.1924	0.4913
1990	1.0148	1.5016	1.3353	0.3081	1.0819	2.0482	0.5984
1991	0.5318	0.9839	1.2182	0.3353	1.2104	0.7749	0.2641
1992	-0.0257	0.2027	-0.2939	0.3024	-0.4998	-0.1353	-0.6037
1993	0.0999	-0.4616	0.0047	0.0473	0.7763	0.8226	0.6336
1994	0.9370	-0.2075	-1.1754	-0.9971	-0.2277	-0.5372	0.4601

Partial variance:

1	2	3	4	5	6	7
0.3914	0.4469	0.4130	0.1228	0.3663	0.8074	0.2315

MASS SEINE Index is tuned to the sum of Jan1 full stock sizes (in number) for age 1.

Year	AGE
1985	-0.3039
1986	-0.1584
1987	0.1113
1988	-0.1546
1989	-0.5259
1990	1.0428
1991	0.9134
1992	0.6084
1993	-0.5978
1994	-0.9353

Partial variance : 0.2389

DELAWARE SURVEY Index is tuned to the sum of Jan1 full stock sizes (in number) for age 1.

Year	AGE
1987	0.2768
1988	-0.6356
1989	-2.5011
1990	1.5774
1991	2.8670
1992	-1.3490
1993	0.3407
1994	-0.5763

Partial variance : 1.5412

Percent of total sum of squares by index & yr; with row/column sums

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	*****
1	0.18	0.41	0.04	0.32	0.01	0.28	0.07	0.06	0.27	0.32	1.96
2	0.09	0.15	0.08	0.03	0.10	0.00	0.10	0.01	0.00	0.02	0.60
3	0.05	0.01	0.10	0.00	0.00	0.01	0.11	0.02	0.24	0.01	0.56
4	0.06	0.21	0.00	0.01	0.02	0.01	0.11	0.12	0.06	0.24	0.83
5	0.41	0.01	1.15	0.24	0.17	0.04	0.03	0.01	0.01	0.03	2.09
6	0.12	0.00	0.69	0.81	0.06	0.70	0.03	0.18	0.06	0.01	2.66
7	0.02	0.15	0.32	0.02	0.19	0.03	0.87	-99.00	0.03	0.00	1.63
8	-99.00	0.00	0.09	1.19	1.24	0.61	0.01	0.01	0.38	0.45	3.97
9	-99.00	0.01	0.03	0.18	0.77	0.00	0.00	0.23	0.87	0.00	2.08
10	-99.00	0.01	0.14	0.19	0.01	0.27	0.14	0.14	0.49	0.02	1.39
11	-99.00	0.09	3.75	0.00	0.42	0.26	0.14	0.09	0.65	0.01	5.41
13	0.17	0.27	0.16	0.28	0.76	0.01	0.29	0.50	0.18	1.50	4.12
14	0.02	0.07	0.05	0.02	0.21	0.08	0.32	0.13	0.99	0.03	1.92
15	0.10	0.05	0.02	0.00	0.00	0.06	0.40	0.00	0.21	0.42	1.26
16	0.00	0.05	0.14	0.06	0.04	0.01	0.77	0.06	0.03	0.20	1.37
17	0.01	0.00	0.04	0.09	0.28	0.26	0.50	0.90	0.01	0.07	2.16
18	0.33	0.01	0.00	0.98	0.52	1.94	0.01	1.99	0.03	0.79	6.61

19	0.49	0.02	0.10	0.18	0.99	0.02	0.57	1.75	2.39	1.05	7.55
20	0.05	0.45	1.29	0.67	1.38	0.00	0.00	0.09	0.48	1.50	5.62
21	0.05	0.11	0.51	0.01	0.01	0.01	0.25	0.98	0.19	0.06	2.19
22	0.13	0.10	0.47	0.09	0.00	0.00	0.37	1.22	0.24	0.40	3.04
23	0.02	0.13	0.46	0.31	0.01	0.05	0.41	0.97	1.72	0.15	4.22
24	0.00	0.00	0.49	0.26	0.00	0.05	0.19	0.55	1.13	0.00	2.68
25	0.06	0.54	0.21	0.09	0.01	0.02	0.22	0.91	1.12	0.07	3.27
26	0.29	0.27	0.17	0.02	0.26	0.15	0.49	0.56	1.07	0.12	3.40
27	0.16	0.82	0.34	0.08	0.28	0.23	0.34	0.44	1.20	0.40	4.27
28	0.82	0.37	0.15	0.04	0.05	0.34	0.09	0.00	0.00	0.29	2.15
29	0.37	0.52	0.21	0.08	0.11	0.75	0.32	0.01	0.07	0.01	2.46
30	0.18	0.23	0.10	0.04	0.16	0.59	0.49	0.03	0.00	0.46	2.27
31	0.01	0.13	0.05	0.00	0.06	0.03	0.04	0.03	0.00	0.33	0.68
32	0.34	0.12	0.23	0.06	0.09	0.39	0.49	0.08	0.20	0.02	2.01
33	1.42	0.38	0.24	0.01	0.47	1.39	0.20	0.01	0.22	0.10	4.44
34	0.67	0.05	0.00	0.01	0.08	0.12	0.02	0.12	0.13	0.07	1.27
44	0.03	0.01	0.00	0.01	0.09	0.36	0.28	0.12	0.12	0.29	1.31
45	-99.00	-99.00	0.03	0.13	2.08	0.83	2.73	0.60	0.04	0.11	6.55
**	6.66	5.74	11.85	6.50	10.63	9.91	11.41	12.91	14.85	9.54	100.00

Partial variance (and proportion of total) by index

	1	2	3	4	5	6	7	8	9	10	11	13
**	0.3569	0.1090	0.1023	0.1514	0.3800	0.4836	0.3340	0.8154	0.4268	0.2844	1.1096	0.7492
**	0.0189	0.0058	0.0054	0.0080	0.0201	0.0256	0.0177	0.0432	0.0226	0.0151	0.0588	0.0397
	14	15	16	17	18	19	20	21	22	23	24	25
**	0.3483	0.2284	0.2487	0.3919	1.2018	1.3728	1.0220	0.3979	0.5530	0.7682	0.4883	0.5939
**	0.0185	0.0121	0.0132	0.0208	0.0637	0.0727	0.0542	0.0211	0.0293	0.0407	0.0259	0.0315
	26	27	28	29	30	31	32	33	34	44	45	*****
**	0.6188	0.7770	0.3914	0.4469	0.4130	0.1228	0.3663	0.8074	0.2315	0.2389	1.5412	18.8729
**	0.0328	0.0412	0.0207	0.0237	0.0219	0.0065	0.0194	0.0428	0.0123	0.0127	0.0817	1.0000

STOCK NUMBERS (Jan 1) in thousands

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	34619	32799	25979	26752	23167	17168	14564	15001	39385	11386
2	28706	28093	26659	21203	21827	18549	14023	11877	12259	31997
3	26945	16838	17275	17060	13794	13124	13278	8743	8364	8171
4	10078	10446	5550	6001	5460	4801	5067	4410	3125	3836
5	4603	2773	4738	1747	1327	1301	1278	1122	1275	996
6	2944	1097	1318	1433	339	318	371	270	309	515
7	2229	875	730	432	311	223	165	86	225	191
1+	110125	92921	82249	74629	66225	55483	48747	41509	64942	57092

Summaries for ages 2-5 3-5 4-5 5-5

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
2	70332	58150	54222	46012	42407	37774	33646	26152	25024	45000
3	41626	30058	27563	24808	20580	19225	19623	14275	12765	13002
4	14681	13219	10288	7749	6787	6101	6345	5533	4401	4831
5	4603	2773	4738	1747	1327	1301	1278	1122	1275	996

FISHING MORTALITY

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.01
2	0.33	0.29	0.25	0.23	0.31	0.13	0.27	0.15	0.21
3	0.75	0.91	0.86	0.94	0.86	0.75	0.90	0.83	0.58
4	1.09	0.59	0.96	1.31	1.23	1.12	1.31	1.04	0.94
5	1.23	0.54	1.00	1.44	1.23	1.06	1.36	1.09	0.71
6	1.18	0.59	1.00	1.41	1.29	1.15	1.38	1.09	0.83
7	1.18	0.59	1.00	1.41	1.29	1.15	1.38	1.09	0.83

Avg F for ages 2-5 3-5 4-5 5-5

	1985	1986	1987	1988	1989	1990	1991	1992	1993
2 ■	0.85	0.58	0.76	0.98	0.91	0.77	0.96	0.78	0.61
3 ■	1.02	0.68	0.94	1.23	1.11	0.98	1.19	0.99	0.74
4 ■	1.16	0.57	0.98	1.38	1.23	1.09	1.33	1.07	0.83
5 ■	1.23	0.54	1.00	1.44	1.23	1.06	1.36	1.09	0.71

BACKCALCULATED PARTIAL RECRUITMENT

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1 ■	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.01
2 ■	0.27	0.31	0.25	0.16	0.24	0.12	0.20	0.14	0.22
3 ■	0.61	1.00	0.85	0.65	0.66	0.65	0.65	0.76	0.61
4 ■	0.88	0.65	0.95	0.91	0.96	0.98	0.95	0.96	1.00
5 ■	1.00	0.60	0.99	1.00	0.95	0.92	0.98	1.00	0.75
6 ■	0.95	0.65	1.00	0.98	1.00	1.00	1.00	1.00	0.88
7 ■	0.95	0.65	1.00	0.98	1.00	1.00	1.00	1.00	0.88

MEAN BIOMASS (MT)

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1 ■	3468	3821	1081	944	2451	1274	1225	1073	6010
2 ■	6274	6496	6172	4808	4414	4651	3543	2875	3366
3 ■	6338	4048	4095	3574	3221	3335	3379	2332	2672
4 ■	2729	3465	1813	1573	1473	1398	1397	1514	1102
5 ■	1276	1340	1313	544	466	498	391	506	578
6 ■	747	667	432	369	126	141	153	143	170
7 ■	742	581	362	178	174	121	97	68	164
1+■	21573	20419	15268	11990	12325	11419	10186	8511	14061

Summaries for ages 2-5 3-5 4-5 5-5

	1985	1986	1987	1988	1989	1990	1991	1992	1993
2 ■	16616	15350	13392	10500	9573	9882	8710	7226	7718
3 ■	10343	8854	7220	5691	5160	5231	5168	4351	4352
4 ■	4005	4805	3126	2118	1939	1895	1788	2019	1680
5 ■	1276	1340	1313	544	466	498	391	506	578

CATCH BIOMASS (MT)

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1 ■	31	28	3	3	55	3	5	2	46
2 ■	2092	1859	1521	1106	1363	625	965	433	692
3 ■	4738	3683	3510	3357	2755	2507	3049	1932	1549
4 ■	2975	2047	1733	2060	1818	1570	1827	1575	1040
5 ■	1575	729	1307	784	573	526	530	551	408
6 ■	879	393	434	518	162	162	212	156	140
7 ■	873	343	364	250	224	139	134	74	135
1+■	13163	9082	8872	8079	6950	5532	6721	4723	4012

Catch Biomass Summaries for ages 2-5 3-5 4-5 5-5

	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	11380	8318	8071	7307	6509	5227	6371	4491	3690
3	9288	6459	6550	6201	5146	4603	5405	4058	2997
4	4550	2776	3040	2844	2391	2095	2357	2126	1449
5	1575	729	1307	784	573	526	530	551	408

SSB AT THE START OF THE SPAWNING SEASON - males & females (MT)

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	3865	2485	2570	2373	1991	1892	2061	1436	1414
4	3122	3636	2036	1958	1724	1629	1717	1709	1234
5	1458	1408	1853	786	605	616	555	592	704
6	1156	651	670	543	178	185	212	164	219
7	1086	737	510	274	261	176	148	97	221
1+	10687	8917	7640	5934	4760	4500	4694	3999	3792

The above SSBs by age (a) and year (y) are calculated following the algorithm used in the NEFSC projection program, i.e.

$$SSB(a,y) = W(a,y) \times P(a,y) \times N(a,y) \times \exp[-Z(a,y)]$$

where $Z(a,y) = 0.1667 \times M(a,y) + 0.1667 \times F(a,y)$

$N(a,y)$ - Jan 1 stock size estimates (males & females)

$P(a,y)$ - proportion mature (generally females)

$W(a,y)$ - weight at age at the beginning of the spawning season

The $W(a,y)$ are assumed to be the same as the Jan1 weight at age estimates (see "WT AT AGE" table in input section). Jan1 weights at age are calculated as geometric means in ADAPT from the mid-year weight at age estimates (from the catch) of the cohort in successive years.

MEAN STOCK NUMBERS (thousands)

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	31242	29623	23510	24206	20773	15543	13175	13584	35563
2	22247	22247	21504	17234	17108	15767	11176	10018	10077
3	17412	10171	10663	10182	8521	8466	8046	5461	5809
4	5661	7220	3290	3097	2899	2662	2617	2527	1862
5	2444	1956	2763	858	706	741	648	631	839
6	1599	758	766	713	176	174	186	152	193
7	1210	605	425	215	162	122	83	49	140
1+	81816	72581	62922	56506	50345	43475	35931	32420	54483

Table 16. Results of bootstrap analysis of virtual population analysis of winter flounder in Southern New England/Mid-Atlantic stock.

SEED FOR THE RANDOM NUMBER GENERATOR: 74747 MAIN LOOP LIMIT IN MARQUARDT ALGORITHM: 50
NUMBER OF BOOTSTRAP REPLICATIONS ATTEMPTED: 200 NUMBER FOR WHICH NLLS CONVERGED: 200

Results from the converged replications are used for computing the statistics that follow. Other replications are ignored.

What Age-specific stocksizes (on Jan 1, 1994) estimated by NLLS

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1.139E4	1.173E4	2.982E3	0.26	3.389E2	2.109E2	2.98	1.105E4	0.27
3.200E4	3.359E4	6.837E3	0.21	1.594E3	4.835E2	4.98	3.040E4	0.22
8.171E3	8.436E3	1.766E3	0.22	2.651E2	1.249E2	3.24	7.906E3	0.22
3.836E3	3.914E3	9.118E2	0.24	7.812E1	6.448E1	2.04	3.758E3	0.24
9.956E2	1.067E3	2.661E2	0.27	7.093E1	1.882E1	7.12	9.247E2	0.29
5.152E2	5.122E2	1.378E2	0.27	-2.991E0	9.744E0	-0.58	5.182E2	0.27
1.107E2	1.154E2	3.912E1	0.35	4.655E0	2.766E0	4.20	1.061E2	0.37

q unscaled Catchability estimates (q) for each index of abundance used in the ADAPT run. Note that these q's have been re-scaled to original units.

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
6.880E-6	7.108E-6	1.570E-6	0.23	2.280E-7	1.110E-7	3.31	6.652E-6	0.24
2.867E-5	2.991E-5	6.578E-6	0.23	1.240E-6	4.651E-7	4.32	2.744E-5	0.24
6.032E-5	6.033E-5	1.272E-5	0.21	5.019E-9	8.994E-7	0.01	6.032E-5	0.21
5.298E-5	5.402E-5	1.232E-5	0.23	1.039E-6	8.708E-7	1.96	5.194E-5	0.24
4.932E-5	4.918E-5	1.171E-5	0.24	-1.422E-7	8.283E-7	-0.29	4.946E-5	0.24
4.354E-5	4.532E-5	1.093E-5	0.25	1.778E-6	7.728E-7	4.08	4.176E-5	0.26
5.590E-5	5.623E-5	1.355E-5	0.24	3.288E-7	9.584E-7	0.59	5.558E-5	0.24
5.619E-6	5.838E-6	1.301E-6	0.23	2.187E-7	9.201E-8	3.89	5.401E-6	0.24
6.388E-5	6.547E-5	1.421E-5	0.22	1.588E-6	1.005E-6	2.49	6.229E-5	0.23
1.039E-4	1.056E-4	2.228E-5	0.21	1.663E-6	1.576E-6	1.60	1.023E-4	0.22
7.337E-5	7.332E-5	1.720E-5	0.23	-5.027E-8	1.216E-6	-0.07	7.342E-5	0.23
2.118E-4	2.188E-4	4.850E-5	0.23	6.972E-6	3.429E-6	3.29	2.049E-4	0.24
4.060E-4	4.161E-4	8.751E-5	0.22	1.015E-5	6.188E-6	2.50	3.958E-4	0.22
7.865E-4	7.886E-4	1.751E-4	0.22	2.116E-6	1.238E-5	0.27	7.843E-4	0.22
6.877E-4	7.110E-4	1.451E-4	0.21	2.329E-5	1.026E-5	3.39	6.644E-4	0.22
4.394E-4	4.492E-4	9.421E-5	0.21	9.822E-6	6.662E-6	2.24	4.296E-4	0.22
3.665E-4	3.636E-4	7.321E-5	0.20	-2.977E-6	5.177E-6	-0.81	3.695E-4	0.20
6.289E-4	6.622E-4	1.381E-4	0.22	3.324E-5	9.766E-6	5.28	5.957E-4	0.23
6.607E-5	6.822E-5	1.560E-5	0.24	2.146E-6	1.103E-6	3.25	6.393E-5	0.24
2.141E-4	2.234E-4	5.016E-5	0.23	9.277E-6	3.547E-6	4.33	2.048E-4	0.24
3.334E-4	3.358E-4	7.744E-5	0.23	2.365E-6	5.476E-6	0.71	3.311E-4	0.23
3.331E-4	3.478E-4	7.448E-5	0.22	1.478E-5	5.266E-6	4.44	3.183E-4	0.23
3.316E-4	3.395E-4	6.888E-5	0.21	7.815E-6	4.871E-6	2.36	3.238E-4	0.21
4.780E-4	4.810E-4	1.098E-4	0.23	3.025E-6	7.766E-6	0.63	4.750E-4	0.23
4.784E-4	4.840E-4	1.092E-4	0.23	5.541E-6	7.719E-6	1.16	4.729E-4	0.23
2.584E-4	2.641E-4	5.758E-5	0.22	5.732E-6	4.072E-6	2.22	2.527E-4	0.23
4.422E-4	4.550E-4	1.043E-4	0.24	1.283E-5	7.373E-6	2.90	4.293E-4	0.24
2.308E-3	2.338E-3	5.228E-4	0.23	2.927E-5	3.697E-5	1.27	2.279E-3	0.23
1.825E-3	1.851E-3	4.032E-4	0.22	2.541E-5	2.851E-5	1.39	1.800E-3	0.22
1.564E-3	1.591E-3	3.561E-4	0.23	2.697E-5	2.518E-5	1.72	1.537E-3	0.23
1.411E-3	1.435E-3	3.036E-4	0.22	2.333E-5	2.147E-5	1.65	1.388E-3	0.22
1.350E-3	1.373E-3	3.140E-4	0.23	2.338E-5	2.220E-5	1.73	1.326E-3	0.24
8.979E-4	9.234E-4	2.010E-4	0.22	2.549E-5	1.421E-5	2.84	8.724E-4	0.23
1.146E-5	1.182E-5	3.028E-6	0.26	3.548E-7	2.141E-7	3.09	1.111E-5	0.27
5.348E-6	5.553E-6	1.236E-6	0.23	2.059E-7	8.740E-8	3.85	5.142E-6	0.24

N t1 Full vector of age-specific stock sizes on Jan 1, 1994

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1.139E4	1.173E4	2.982E3	0.26	3.389E2	2.109E2	2.98	1.105E4	0.27
3.200E4	3.359E4	6.837E3	0.21	1.594E3	4.835E2	4.98	3.040E4	0.22
8.171E3	8.436E3	1.766E3	0.22	2.651E2	1.249E2	3.24	7.906E3	0.22
3.836E3	3.914E3	9.118E2	0.24	7.812E1	6.448E1	2.04	3.758E3	0.24
9.956E2	1.067E3	2.661E2	0.27	7.093E1	1.882E1	7.12	9.247E2	0.29
5.152E2	5.122E2	1.378E2	0.27	-2.991E0	9.744E0	-0.58	5.182E2	0.27
1.912E2	1.992E2	6.780E1	0.35	8.093E0	4.794E0	4.23	1.831E2	0.37

F t Full vector of age-specific terminal F's (in 1993)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
7.721E-3	7.664E-3	1.591E-3	0.21	-5.759E-5	1.125E-4	-0.75	7.779E-3	0.20
2.057E-1	2.071E-1	3.911E-2	0.19	1.358E-3	2.765E-3	0.66	2.044E-1	0.19
5.795E-1	5.894E-1	1.057E-1	0.18	9.896E-3	7.474E-3	1.71	5.696E-1	0.19
9.440E-1	9.290E-1	1.548E-1	0.16	-1.498E-2	1.095E-2	-1.59	9.589E-1	0.16
7.065E-1	7.371E-1	1.437E-1	0.20	3.064E-2	1.016E-2	4.34	6.758E-1	0.21
8.267E-1	8.501E-1	1.993E-1	0.24	2.335E-2	1.409E-2	2.82	8.034E-1	0.25
8.267E-1	8.501E-1	1.993E-1	0.24	2.335E-2	1.409E-2	2.82	8.034E-1	0.25

F full t Fully-recruited F in the terminal year (1993)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
8.257E-1	8.387E-1	1.071E-1	0.13	1.300E-2	7.571E-3	1.57	8.127E-1	0.13

PR t Partial recruitment vector in the terminal year (1993)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
8.180E-3	7.845E-3	2.105E-3	0.26	-3.351E-4	1.489E-4	-4.10	8.515E-3	0.25
2.179E-1	2.116E-1	5.086E-2	0.23	-6.347E-3	3.597E-3	-2.91	2.243E-1	0.23
6.139E-1	6.005E-1	1.339E-1	0.22	-1.337E-2	9.471E-3	-2.18	6.273E-1	0.21
1.000E0	9.333E-1	1.085E-1	0.11	-6.671E-2	7.673E-3	-6.67	1.067E0	0.10
7.484E-1	7.459E-1	1.486E-1	0.20	-2.500E-3	1.051E-2	-0.33	7.509E-1	0.20
8.758E-1	8.511E-1	1.508E-1	0.17	-2.469E-2	1.067E-2	-2.82	9.005E-1	0.17
8.758E-1	8.511E-1	1.508E-1	0.17	-2.469E-2	1.067E-2	-2.82	9.005E-1	0.17

PR mean Average partial recruitment over 1991-1993

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
3.439E-3	3.326E-3	4.295E-4	0.12	-1.132E-4	3.037E-5	-3.29	3.552E-3	0.12
1.811E-1	1.757E-1	1.741E-2	0.10	-5.420E-3	1.231E-3	-2.99	1.865E-1	0.09
6.730E-1	6.541E-1	5.384E-2	0.08	-1.889E-2	3.807E-3	-2.81	6.919E-1	0.08
9.668E-1	9.337E-1	4.851E-2	0.05	-3.311E-2	3.430E-3	-3.42	9.999E-1	0.05
9.020E-1	8.848E-1	5.585E-2	0.06	-1.727E-2	3.949E-3	-1.91	9.193E-1	0.06
9.558E-1	9.322E-1	5.584E-2	0.06	-2.365E-2	3.948E-3	-2.47	9.795E-1	0.06
9.558E-1	9.322E-1	5.584E-2	0.06	-2.365E-2	3.948E-3	-2.47	9.795E-1	0.06

B mean t Mean stock biomass during the terminal year (1993)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1.406E4	1.455E4	1.713E3	0.12	4.878E2	1.212E2	3.47	1.357E4	0.13

SSBaf mean t Mean female SSB during the terminal year (1993)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1.687E3	1.723E3	1.817E2	0.11	3.553E1	1.285E1	2.11	1.652E3	0.11

SSB spawn t SSB (males & females) at start of spawning season (1993)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
3.792E3	3.856E3	3.254E2	0.09	6.365E1	2.301E1	1.68	3.728E3	0.09

Table 17. Yield per recruit and spawning stock biomass per recruit for winter flounder in Southern New England/ Mid-Atlantic stock complex.

Proportion of F before spawning: .200
 Proportion of M before spawning: .200
 Natural Mortality is Constant at: .200
 Last age is a True Age;

Age-specific Input data for Yield per Recruit Analysis

Age	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Stock	Catch
1	.0050	1.0000	.0000	.116	.116
2	.1890	1.0000	.0000	.309	.309
3	.7390	1.0000	.5300	.443	.443
4	1.0000	1.0000	.9500	.595	.595
5	1.0000	1.0000	1.0000	.743	.743
6	1.0000	1.0000	1.0000	.911	.911
7	1.0000	1.0000	1.0000	1.095	1.095
8	1.0000	1.0000	1.0000	1.291	1.291
9	1.0000	1.0000	1.0000	1.467	1.467
10	1.0000	1.0000	1.0000	1.620	1.620
11	1.0000	1.0000	1.0000	1.748	1.748
12	1.0000	1.0000	1.0000	1.855	1.855
13	1.0000	1.0000	1.0000	1.941	1.941
14	1.0000	1.0000	1.0000	2.011	2.011
15	1.0000	1.0000	1.0000	2.067	2.067

Summary of Yield per Recruit Analysis for:
 WINTER FLOUNDER

Slope of the Yield/Recruit Curve at F=0.00: ----->	3.053
F level at slope=1/10 of the above slope (F0.1): --->	.217
Yield/Recruit corresponding to F0.1: --->	.2554
F level to produce maximum Yield/Recruit (Fmax): --->	.536
Yield/Recruit corresponding to Fmax: --->	.2821

WINTER FLOUNDER YPR

	Fishing Mortality	Total Catch Number	Total Catch Weight	Total Stock Number	Total Stock Weight	Spawn Stock Number	Spawn Stock Weight	Percent Max. Spawn Potential
	.000	.00000	.00000	5.2420	3.7669	2.9600	3.1148	1.0000
	.100	.21893	.18573	4.3519	2.5417	2.0732	1.9041	.6113
	.200	.33474	.24961	3.8327	1.9001	1.5624	1.2787	.4105
F0.1	.217	.34949	.25545	3.7640	1.8208	1.4953	1.2020	.3859
	.300	.40491	.27218	3.5016	1.5329	1.2409	.9253	.2970
	.400	.45211	.27992	3.2742	1.3048	1.0232	.7086	.2275
	.500	.48630	.28200	3.1086	1.1528	.8670	.5662	.1818
Fmax	.536	.49652	.28211	3.0592	1.1099	.8209	.5264	.1690
	.600	.51244	.28184	2.9823	1.0455	.7499	.4671	.1500
	.700	.53320	.28076	2.8824	.9660	.6588	.3948	.1267
	.800	.55020	.27934	2.8010	.9049	.5860	.3401	.1092
	.900	.56444	.27780	2.7332	.8563	.5265	.2974	.0955
	1.000	.57659	.27627	2.6757	.8168	.4770	.2633	.0845
	1.100	.58714	.27479	2.6261	.7840	.4352	.2354	.0756
	1.200	.59640	.27338	2.5827	.7562	.3994	.2123	.0682
	1.300	.60464	.27205	2.5444	.7323	.3684	.1928	.0619
	1.400	.61202	.27080	2.5102	.7116	.3414	.1762	.0566
	1.500	.61870	.26962	2.4794	.6933	.3175	.1619	.0520
	1.600	.62478	.26850	2.4514	.6770	.2963	.1494	.0480
	1.700	.63035	.26746	2.4259	.6625	.2774	.1385	.0444
	1.800	.63549	.26647	2.4025	.6494	.2604	.1288	.0413
	1.900	.64025	.26553	2.3809	.6374	.2450	.1202	.0386
	2.000	.64468	.26464	2.3608	.6265	.2311	.1125	.0361

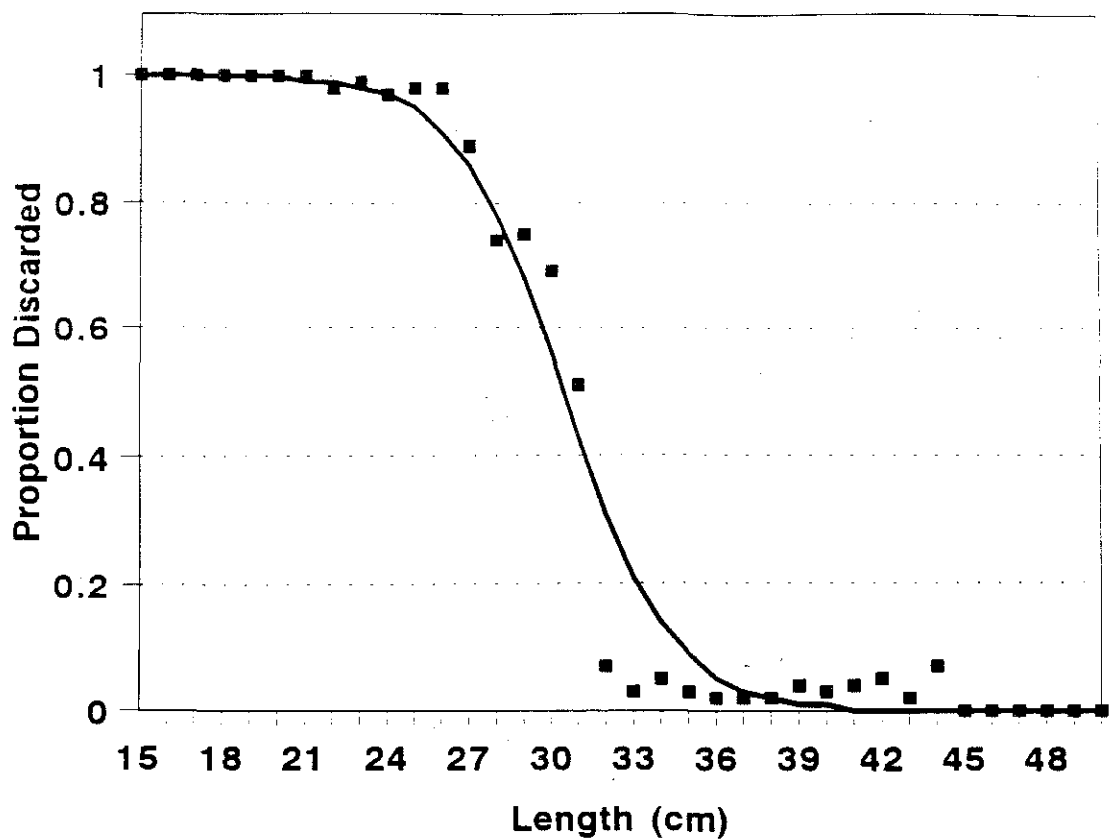


Figure 1. Proportion of winter flounder discarded at length, quarters 1 and 2, as estimated from 1989-1992 sea sampling data; logistic regression smoothing.

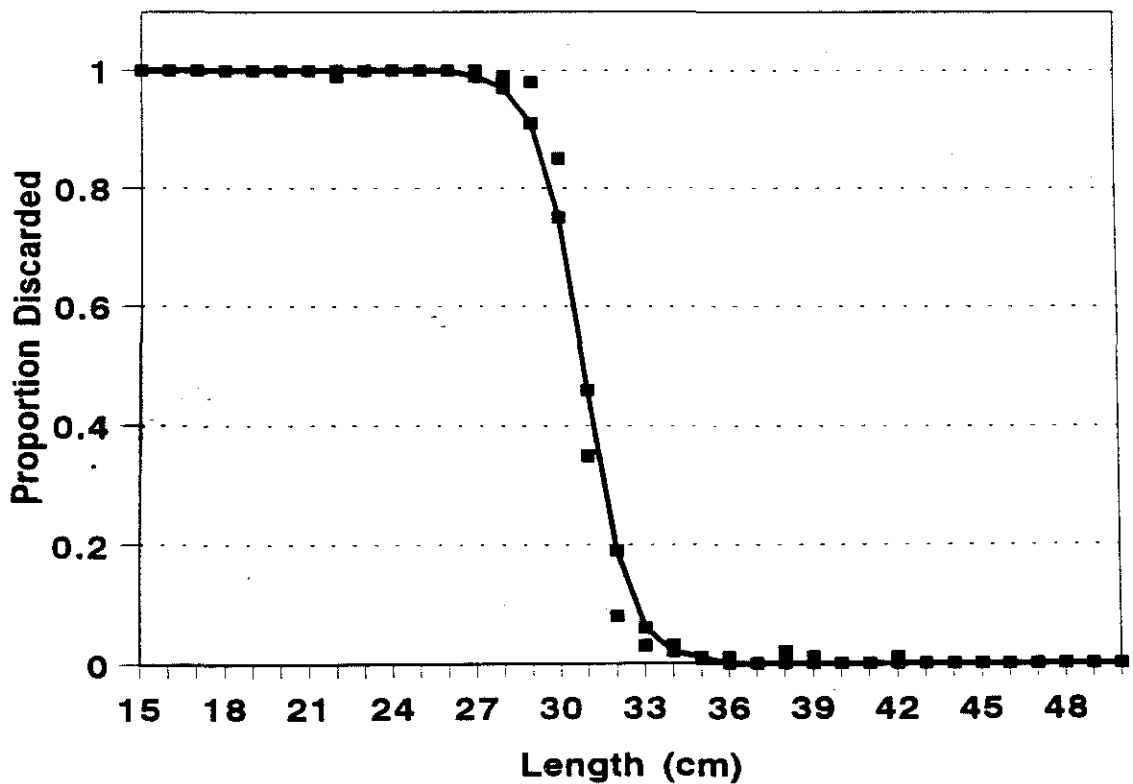


Figure 2. Proportion of winter flounder discarded at length, quarters 3 and 4, as estimated from 1989-1992 sea sampling data; logistic regression smoothing.

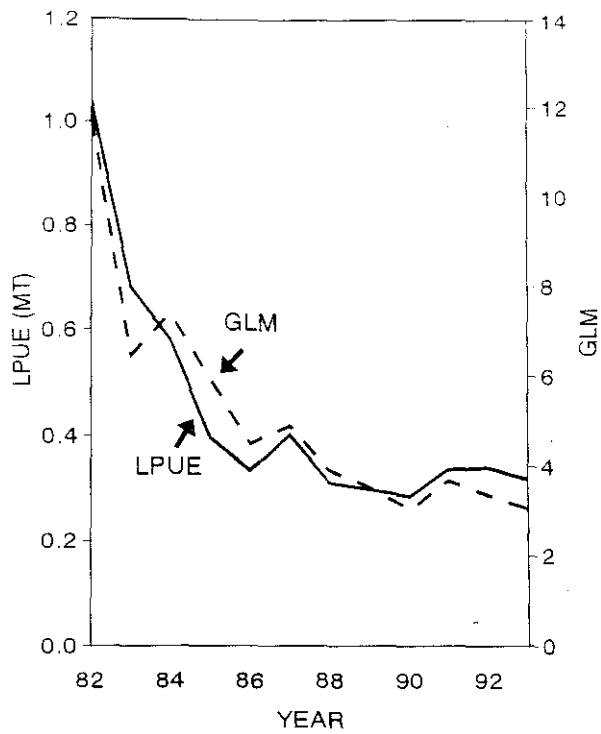


Figure 3. Commercial weight landings per unit effort of winter flounder from otter trawl trips landing winter flounder, Southern New England/Mid-Atlantic stock complex, 1982-1993: raw LPUE and standardized index of abundance based on retransformed year coefficient, GLM.

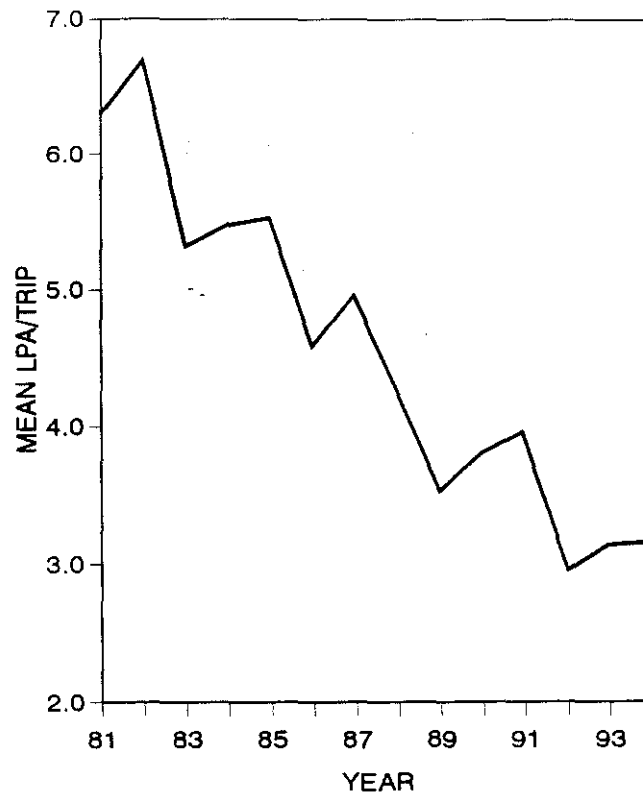


Figure 4. Recreational landings per unit effort of winter flounder as number landed per angler per trip, Southern New England/Mid-Atlantic stock complex, 1981-1994.

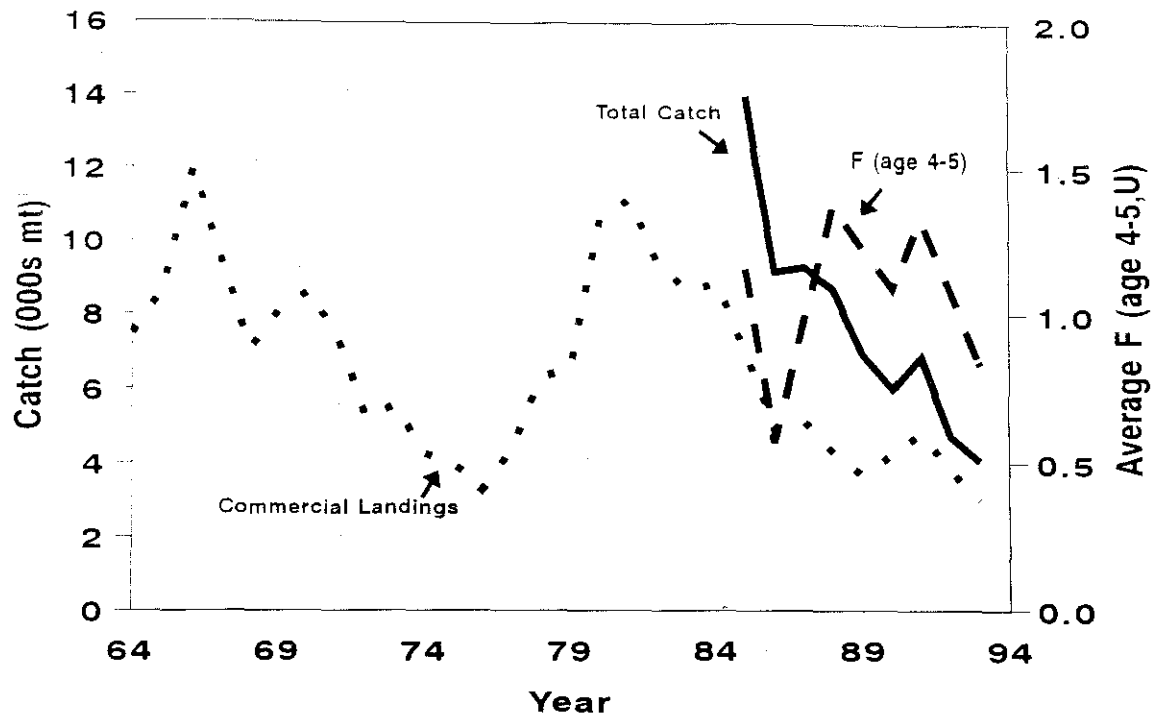


Figure 5. Trends in landings, catch, and fishing mortality rates (unweighted average F at ages 4-5), Southern New England/Mid-Atlantic stock complex of winter flounder, 1964-1993.

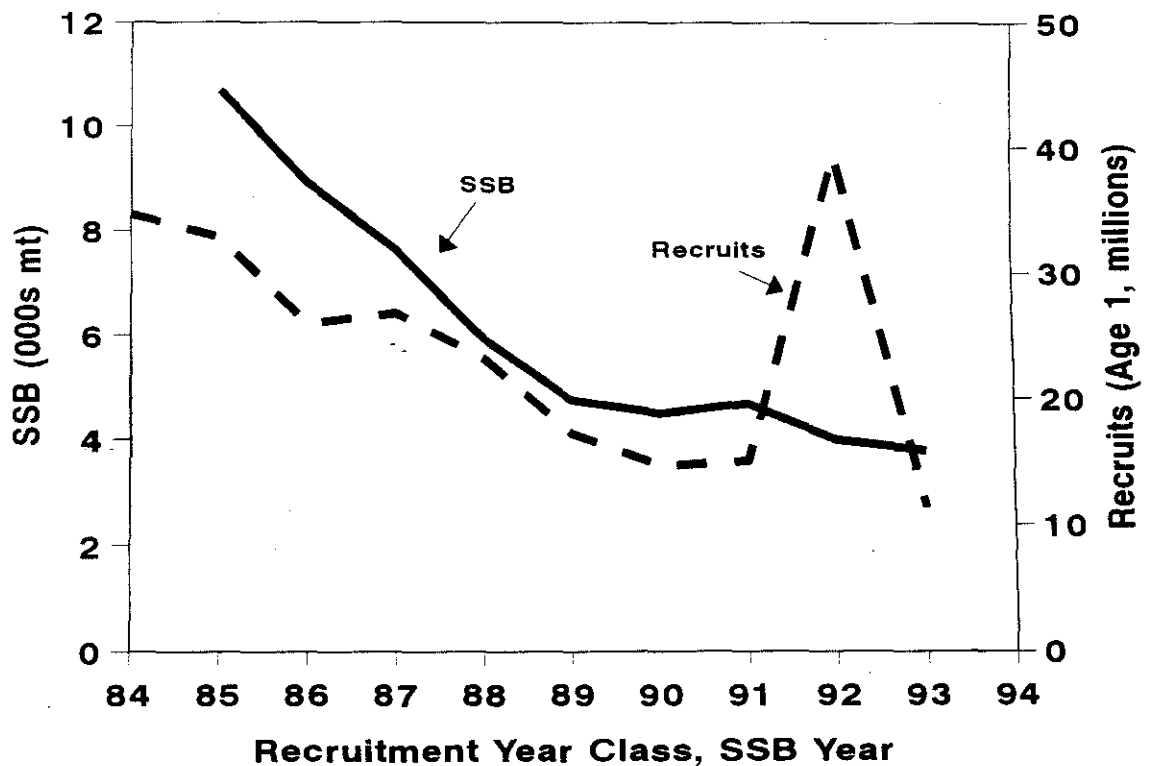


Figure 6. Trends in spawning stock biomass (000 mt) and recruitment (millions age 1), Southern New England/ Mid-Atlantic stock complex of winter flounder, 1985-1993.

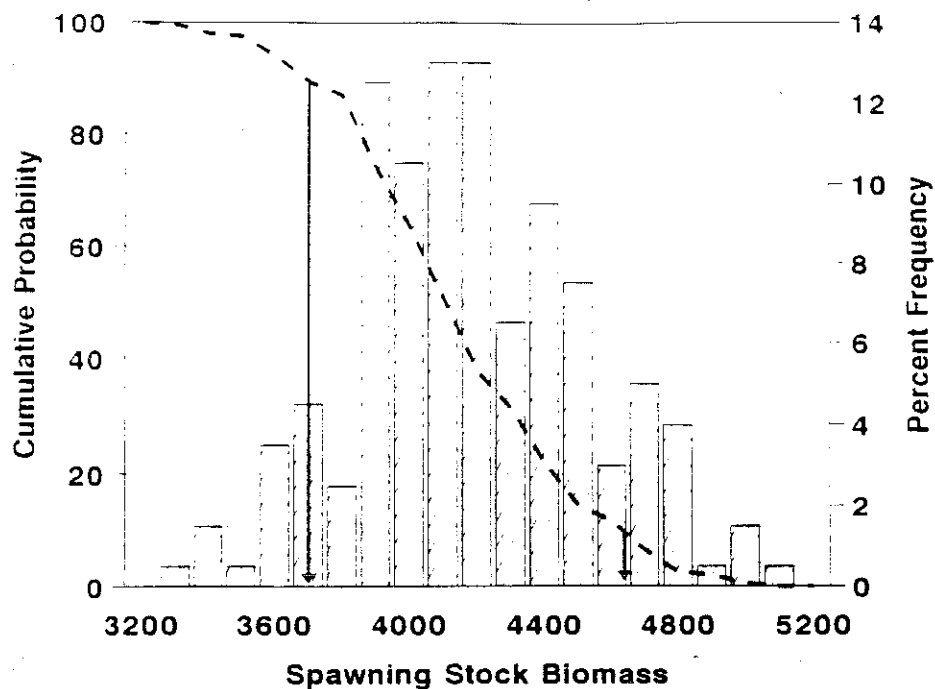


Figure 7. Precision of estimates of spawning stock biomass for Southern New England/Mid-Atlantic stock complex of winter flounder derived from bootstrap procedure. The vertical bars give the range and probability of individual values within that range. The dashed line gives the probability that SSB is less than any selected value on the x-axis.

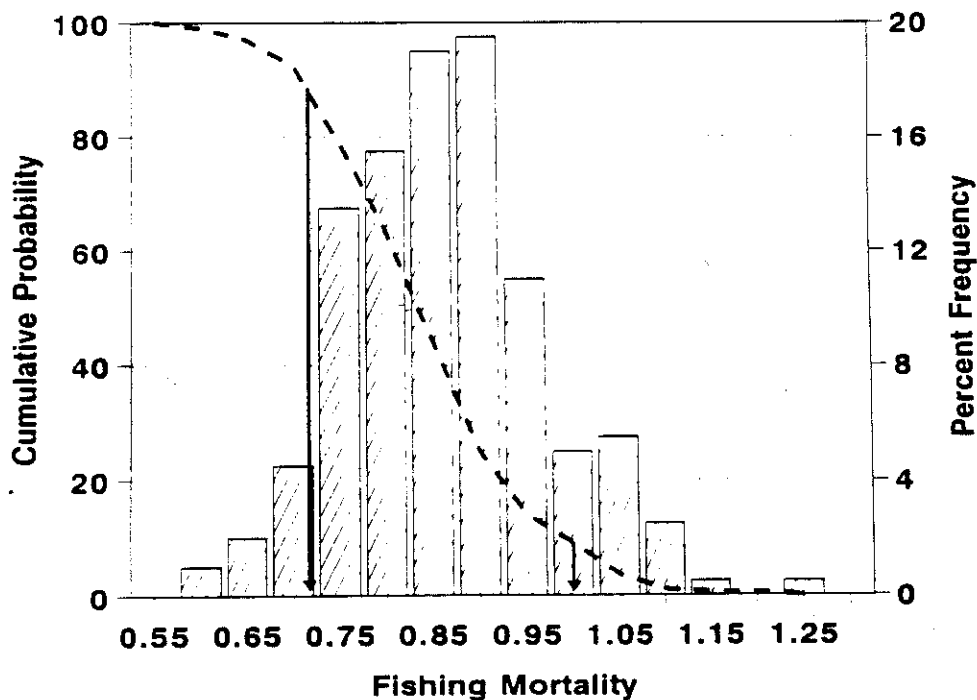


Figure 8. Precision of fishing mortality for Southern New England/Mid-Atlantic stock complex of winter flounder derived from bootstrap procedure. The vertical bars give the range and probability of individual values within that range. The dashed line gives the probability that F is less than any selected value on the x-axis.

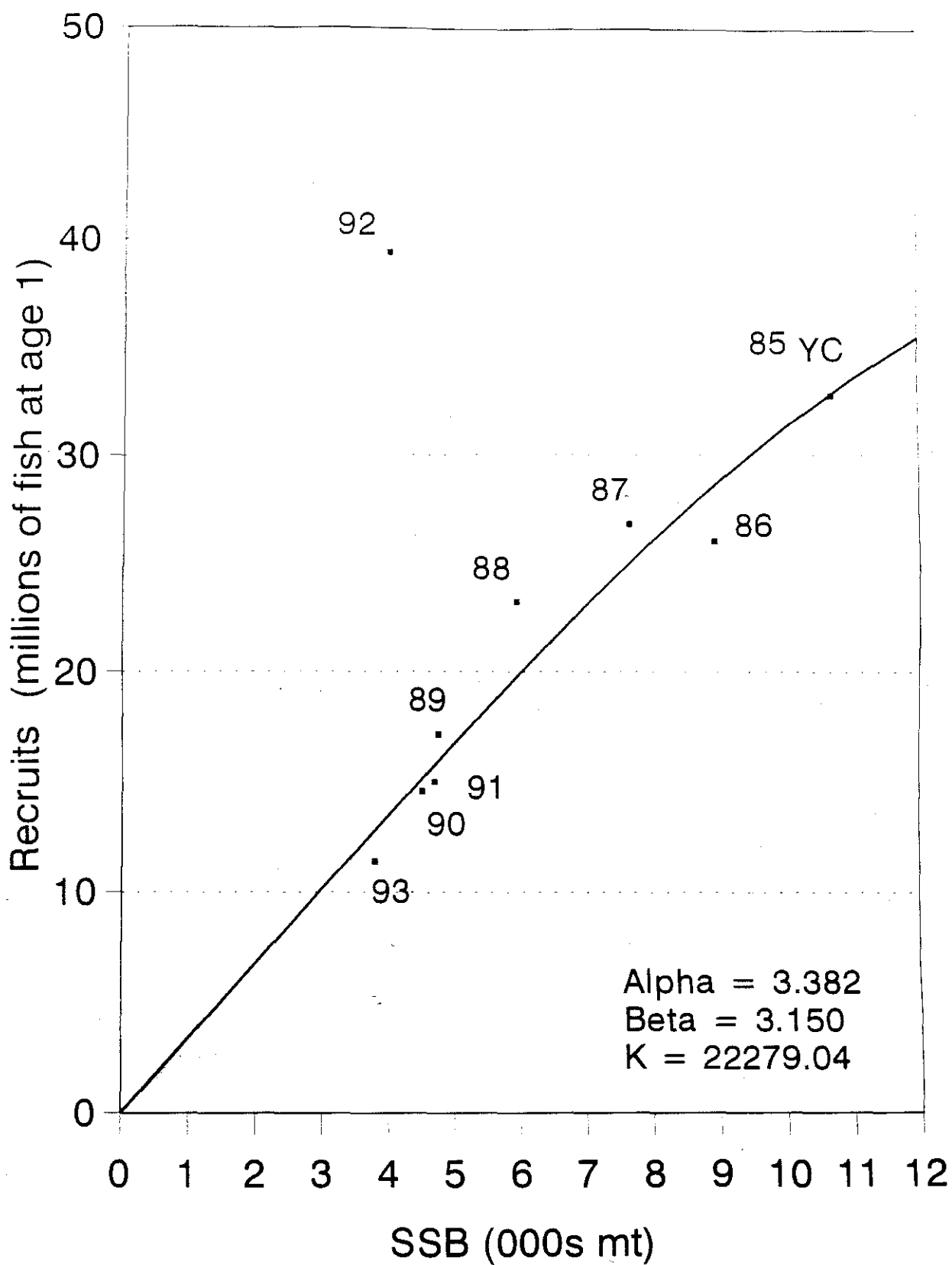


Figure 9. Spawning stock biomass (thousands of metric tons) and recruitment (millions at age 1), Southern New England/Mid-Atlantic stock complex of winter flounder, 1985-1993. Points are labelled by year class. Shepherd stock-recruitment curve fitted excluding the 1992 year class: $\alpha=3.382$, $\beta=3.150$, $K=22279.04$.

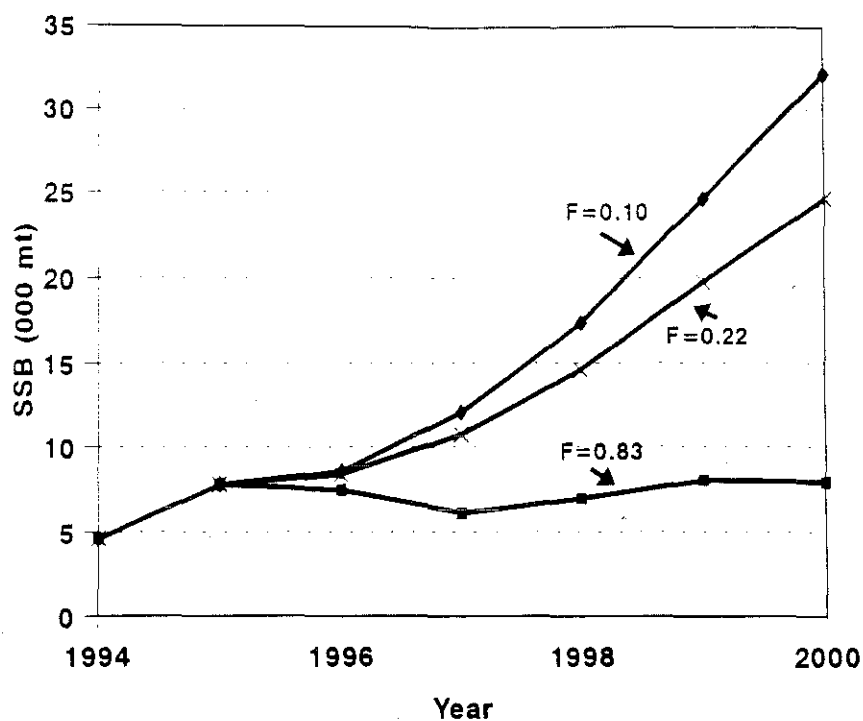


Figure 10. Medium term projections of median spawning stock biomass, Southern New England/ Mid-Atlantic stock complex of winter flounder, 1994-2000, assuming $F=0.83$ (status quo), $F=0.22$ ($F_{0.1}$), and $F=0.10$.

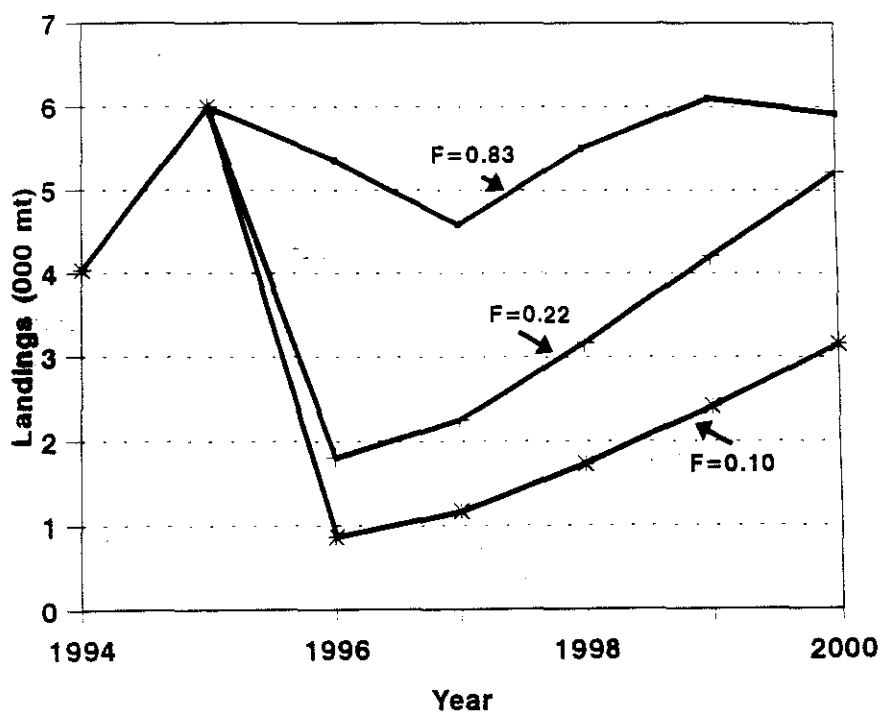


Figure 11. Medium term projections of median landings, Southern New England/ Mid-Atlantic stock complex of winter flounder, 1994-2000, assuming $F=0.83$ (status quo), $F=0.22$ ($F_{0.1}$), and $F=0.10$.

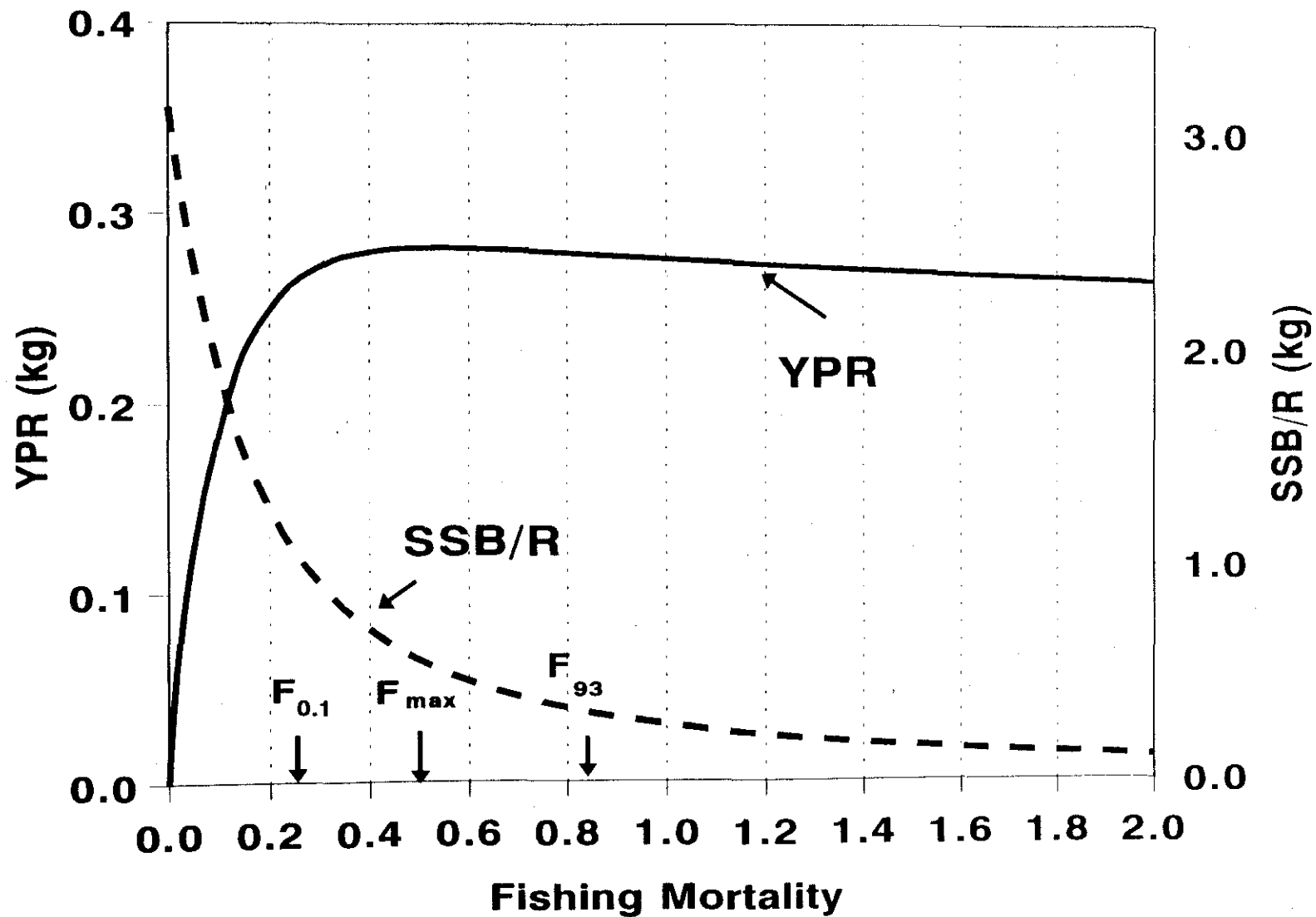


Figure 12. Yield per recruit and spawning stock biomass per recruit of winter flounder in the Southern New England/ Mid-Atlantic stock complex.

Appendix I. Identification of Stock Units

By

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Introduction

The Species Profile presented within the ASMFC Plan discusses in detail the relatively large biological variability among inshore winter flounder populations. The Plan divides these populations into three management units based on available data describing growth, seasonal movements, and female maturity schedules. Since adoption of the Plan, new data have become available which more fully measure the variability found in the southern populations. These data are summarized below. Based on this new information, the Mid-Atlantic and Southern New England management units were combined. The two other units, Gulf of Maine and Georges Bank, remain unchanged.

Seasonal Movements

Phelan (1992) collected and tagged 7,346 flounder from 14 inshore and 22 offshore stations associated with a sewage sludge dumpsite 22 km (12 mi) off the New Jersey coast. Previous tagging studies in this region had only tagged fish from inshore sites. Movement of the 206 fish recaptured with tags showed that while the majority returned to inshore spawning areas, a component of the population remained on the dumpsite during the winter spawning season. Tag returns from these overwintering adults (N=44) were equally divided between fish moving to local inshore areas less than 40 km (22 mi) from the dumpsite and those moving longer distances to the east, including Block Island and Vineyard Sounds. These results indicate that there is intermixing of flounder from the New York Bight and Block Island Sound-Southern Massachusetts region through gradual dispersion of a segment of the population which may not spawn every winter.

Growth

Length-at-age data from coastal New Jersey were gathered in April 1993 and 1994. Previous age data from this area were available only from inshore samples. These new data show that growth is more variable than previous studies had indicated. Earlier work documented the relatively slow growth of the inshore fish, but had not included the faster growing fish at each age found in the coastwide survey. Length frequency distributions for age 3, 4 and 5 fish collected from New Jersey, Connecticut and Massachusetts waters during the same years and seasons are depicted in Figures 1-3. Although these new data show no statistical difference between the New Jersey and Connecticut growth patterns, differences were detected between New Jersey and southern Massachusetts, primarily because the Massachusetts samples had few fish in the smallest length intervals for each age, resulting in a higher mean (Table 1). However, all three areas have a similar proportion of the largest fish at each age. Based on the similarity of growth and maximum age, the estimate of natural mortality was revised downward to reflect the oldest fish aged (MA DMF, age 17, $m=0.20$).

Maturity

Female flounder captured throughout Long Island Sound in April and May, 1991-1993, were examined to determine percent maturity at age (CTDEP 1995). Previous data had examined fish from small areas in western and eastern portions of the Sound. These new data showed a larger percentage of age-three fish to be mature (66% versus 38-47%), comparable to the 70% maturity reported by Danilla (1978) for age-three flounder captured in New Jersey. Percent maturity for age-four fish was also higher (97% versus 79-80%), similar to the 99% previously reported for New Jersey. This maturity schedule is not significantly different from that reported for southern Massachusetts (53% for age three and 95% for age four).

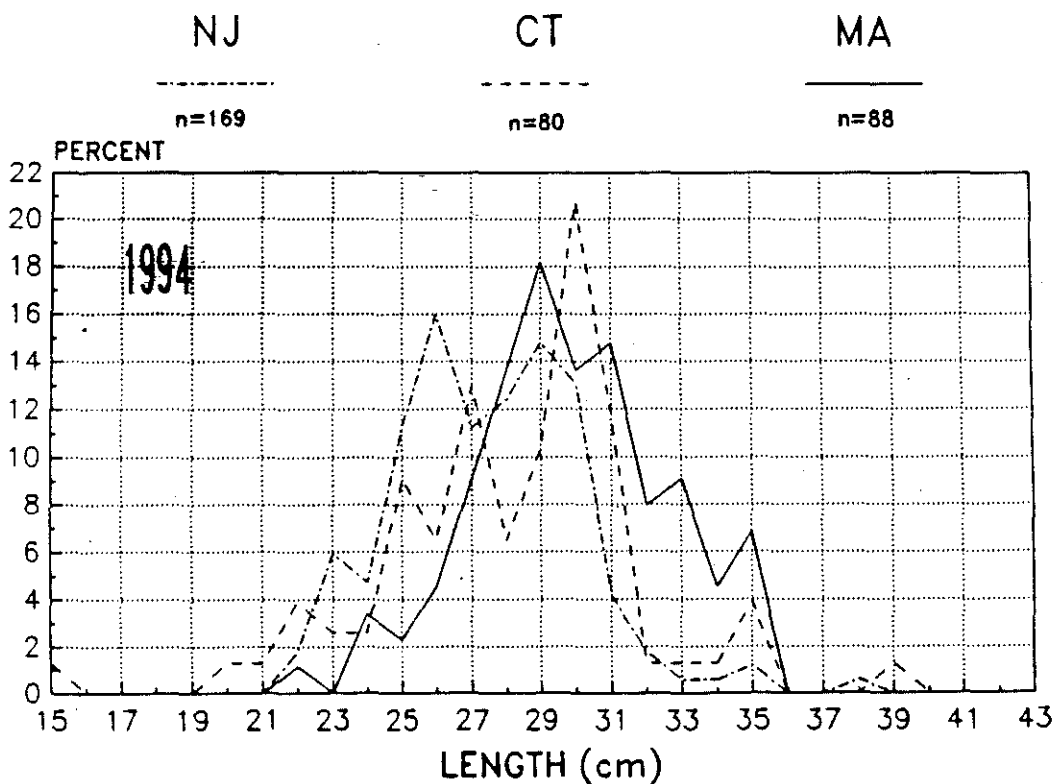
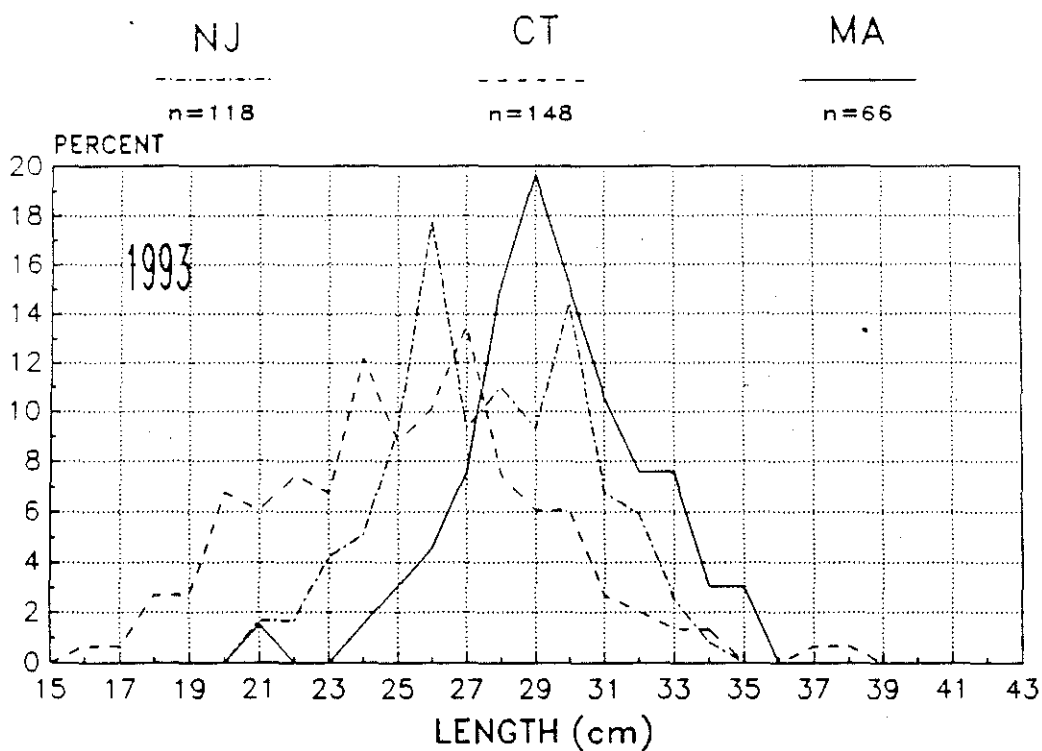
Literature Cited

- Danilla, D. 1978. Age, growth, and other aspects of the life history of the winter flounder *Pseudopleuronectes americanus* (Walbaum) in the southern New Jersey. M.S. Rutgers University, New Brunswick, NJ. 79 pp.
- Phalen, B. 1992. Winter flounder movements in the inner New York Bight. Transactions of the American Fisheries Society 121:777-784.

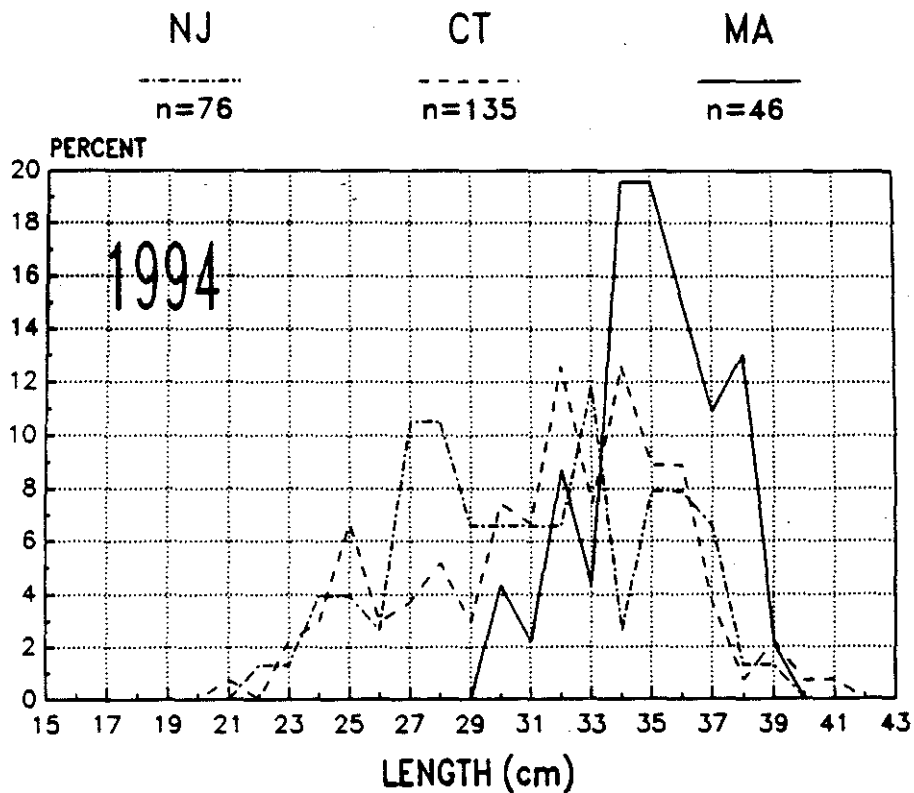
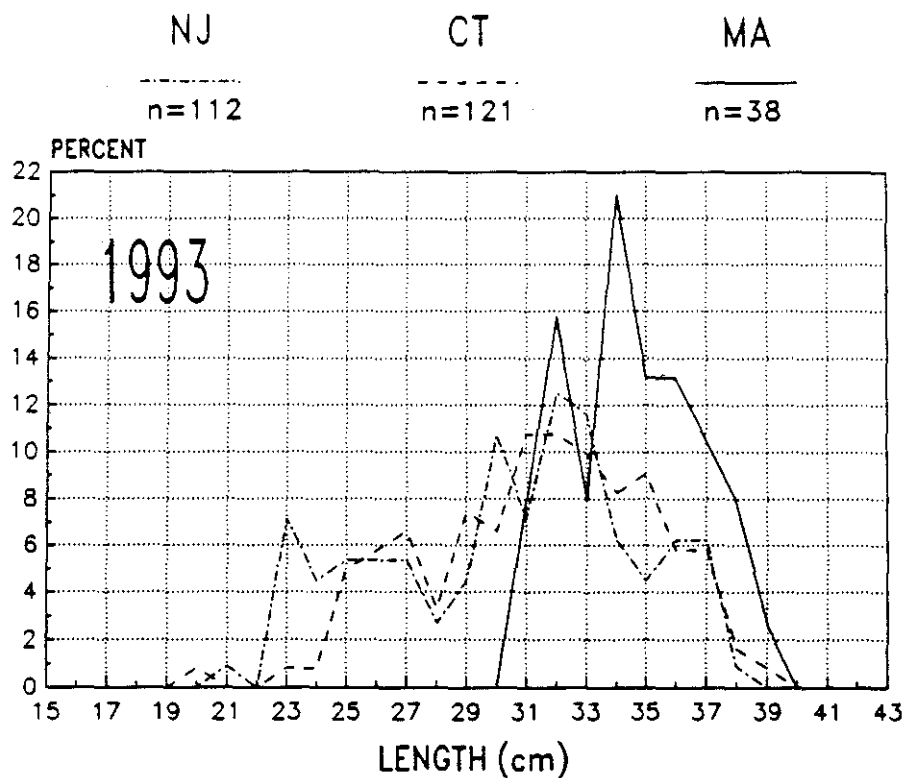
Table 1. Mean lengths at age (with standard error, sample size) for New Jersey, Connecticut and Massachusetts.

AGE 3	New Jersey	Connecticut	Massachusetts	P-value
1993	27.6 (0.85, 118)	25.3 (0.74, 148)	29.5 (1.14, 66)	0.01*
1994	27.4 (0.63, 169)	28.3 (0.94, 80)	29.8 (0.84, 88)	0.09
AGE 4				
1993	30.4 (0.92, 112)	31.4 (0.89, 121)	34.5 (1.59, 38)	0.10
1994	30.8 (1.06, 76)	31.6 (1.36, 135)	35.0 (1.36, 46)	0.05*
AGE 5				
1993	33.0 (0.88, 100)	33.4 (0.80, 120)	38.1 (2.35, 14)	0.13
1994	35.2 (1.42, 25)	34.7 (0.81, 78)	39.4 (2.36, 9)	0.18

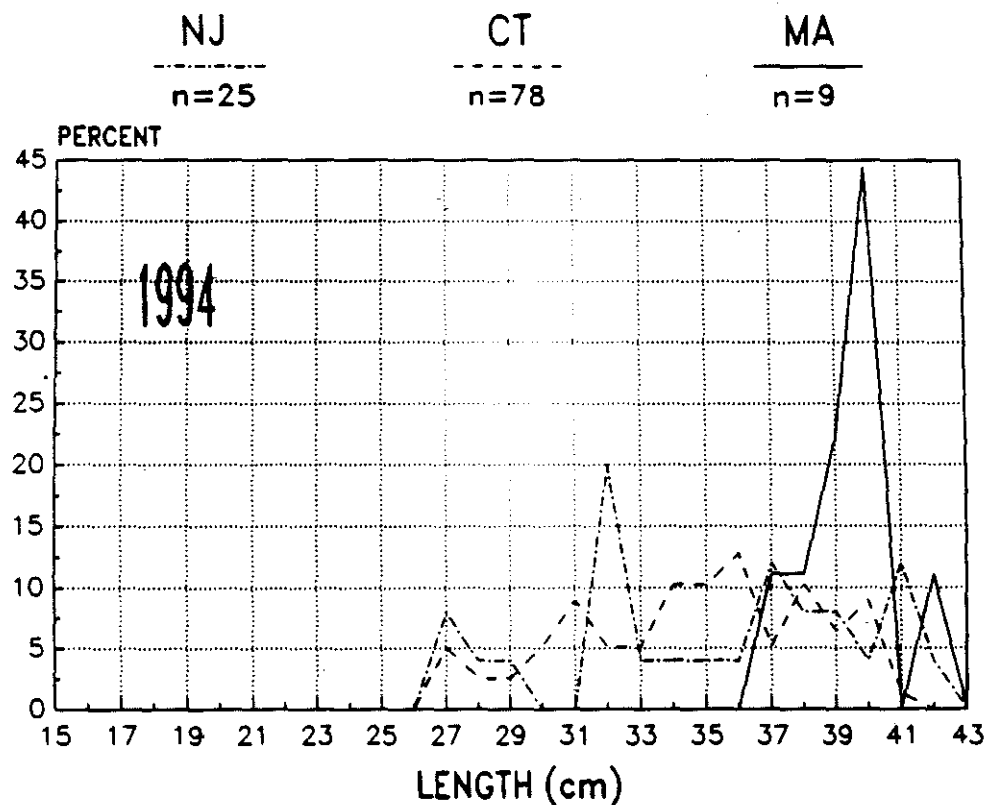
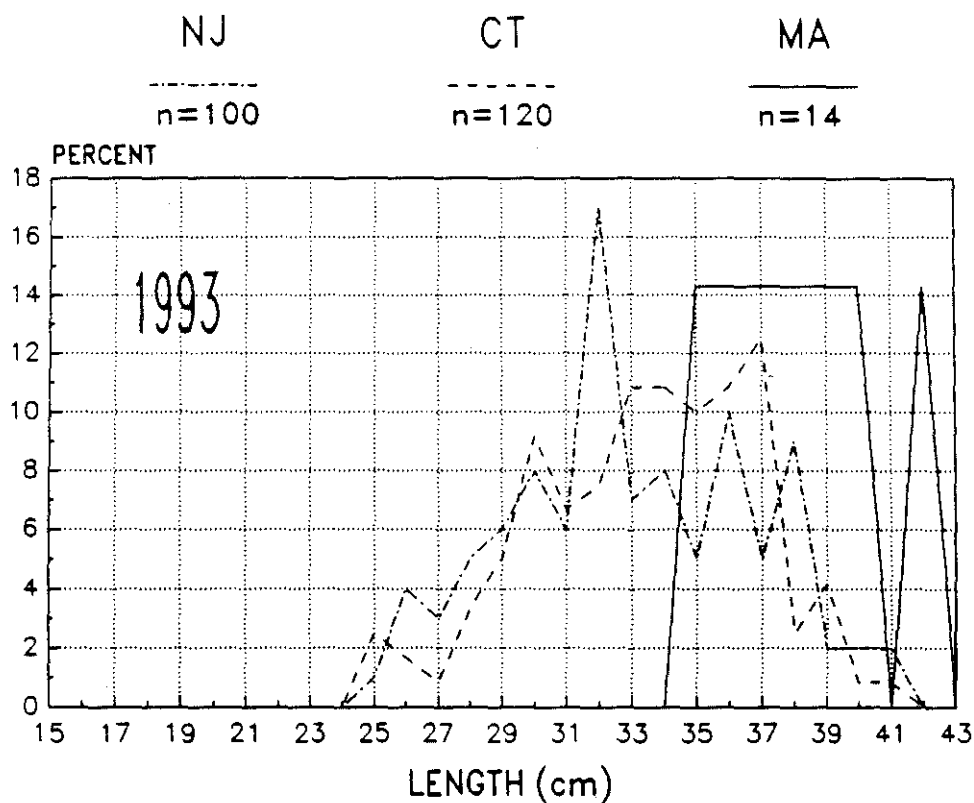
LENGTH FREQUENCIES OF AGE THREE WINTER FLOUNDER



LENGTH FREQUENCIES OF AGE FOUR WINTER FLOUNDER



LENGTH FREQUENCIES OF AGE FIVE WINTER FLOUNDER



Appendix II. Age Structure of Winter Flounder B2 Type Recreational
Discards Estimated from Inshore Trawl Survey Lengths,
Age-Length Keys, and Minimum Size Regulations.

By
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Introduction

Accurate assessment of valuable commercial and recreational species using age structured methods, requires a complete catch at age matrix which characterizes all removals the stock (Megrey 1989). Failure to account for discarded fish can result in biased low estimates of selectivity at age and recruitment (Rivard 1989). Sustainable fishing rates on fully recruited stock can be overestimated. Recreational discards can comprise a large fraction of a catch at age. Winter flounder along the Atlantic coast from Maine to New Jersey are subject to a substantial recreational fishery. From 1978 to 1988, recreational landings accounted for 31% by weight of all winter flounder landed (ASMFC 1992). With the development and implementation of the Atlantic States Marine Fisheries Commission (ASMFC) fishery management plan in state waters and Fishery Management Council regulations in the EEZ, minimum size regulations for winter flounder have increased in the past decade. This has resulted in an increasing fraction of B2 type catch (fish caught but subsequently released alive) in the recreational data base. For example in Rhode Island, B2 catch has increased from 10% of total to over 30% of total from 1979 to 1994 as size limits were instituted and advanced.

Unlike the commercial fishery, there are no sampling programs for the recreational fishery to characterize discarded fish by size. However, most states conduct inshore trawl surveys to monitor abundance of fishery resources in state waters. These surveys generally employ small mesh bottom trawl gear which catch a wide size range of fish. As an alternative to sea sampling of recreational winter flounder discards, state research trawl surveys were used to characterize the size structure of sublegal fish available to the recreational fishery. In addition to length frequencies and relative abundance, age-length keys are available from several states to assign ages to the recreational length samples.

Methods and Data Sources

Winter flounder length frequency data were obtained from the Massachusetts Division of Marine Fisheries (MADMF), the Rhode Island Division of Fish and Wildlife (RIDFW), the Connecticut Department of Environmental Protection (CTDEP), the New York Department of Environmental Conservation (NYDEC), and the New Jersey Department of Environmental Protection (NJDEP). MADMF data covered years 1980 to 1994 and were collected from spring and fall cruises state waters south and east of Cape Cod. RIDFW spring and fall trawl data from 1979 to 1994 covered Narragansett Bay and Rhode Island coastal waters. The CTDEP survey conducted in Long Island Sound dates from 1984 with both spring and fall cruises. Data from the summer and autumn trawl surveys of Peconic Bay by the NYDEC were available from 1985 and 1987-1994. A trawl survey in coastal waters off New Jersey has been conducted by the NJDEP since 1988. The survey is done bimonthly but only fall data were available for 1988.

Estimates of B2 length structure were limited to years 1985 to 1993, the period covered by the assessment. Spring survey length data were used except for the NYDEC

survey. Length samples to characterize B2 discards were restricted to a size range which corresponded to a minimum hookable size and the minimum legal size by year and state. Minimum hookable size was set at 13 cm based on examination of MRFSS A length samples (fish caught and retained) in years without size limits. For states without minimum size regulations, an effective minimum retention size of 20 cm (7.9") was assumed based on NYDEC party boat measurements and American Littoral Society tagging data. A history of recreational size limit regulations was obtained from each state. Massachusetts had an 11" minimum size in 1985 which increased to 12" in 1986. Rhode Island had no minimum size up to 1985 but implemented an 11" minimum in 1986. This increased to 11.5" in 1990 and 12" in 1991. Connecticut had a 10" minimum size from 1985 to 1993 and recently increased it to 11" in 1994. New York had no minimum size in 1985-1986, an 8" minimum from 1987 to 1990, a 9" size in 1991, 10" from 1992-1993, and finally 11" in 1994. The state of New Jersey had no minimum size from 1985 to 1991 and implemented a 10" minimum in 1992.

In addition to length frequency data, survey age-length keys were available from MADMF, CTDEP, and NJDEP. MADMF annual keys from the spring survey cruise were available from 1984 to 1993. CTDEP age-length keys also began in 1984 and a NJDEP key was available for 1993. MADMF survey length samples were aged from 1985 to 1993 using the MADMF keys. RIDFW lengths from 1985 to 1993 were aged with the MADMF keys after examination of 1987-1988 Rhode Island age data (Hass and Recksiek 1995) indicated a closer match to Massachusetts rather than Connecticut data. CTDEP survey lengths were aged with the CTDEP keys. NYDEC lengths from 1985 to 1993 were aged with the CTDEP keys. No lengths were available in 1986 from the NYDEC survey so 1985 and 1987 data were substituted. The same CTDEP keys were used to age the NJDEP trawl survey lengths from 1988 to 1992. In 1993, a combined CTDEP and NJDEP key was applied to the NJDEP lengths. To complete the NJDEP series, length frequencies from the NMFS/NEFSC spring trawl survey in the southern New England region were substituted for years 1985 to 1987. These were the same length data employed in initial estimation of winter flounder discards (Shepherd 1994) and most resembled the NJDEP length frequencies.

Results

Length frequency data from the various surveys is summarized in Tables 1 and 2. There were some notable differences in the size structure of winter flounder sampled in the spring surveys. First, state surveys in inshore waters had a much higher fraction of catch in small size **classes** (10-20 cm) than did the NMFS/NEFSC survey (Figure 1). Dominance of juvenile fish was most pronounced in the RIDFW survey in Narragansett Bay. This reflects the tendency of juvenile winter flounder to inhabit estuarine areas. Secondly, the RIDFW and CTDEP surveys had very few fish in excess of 40 cm. It is unclear whether this represents high mortality rates or movement of larger individuals from Narragansett Bay and Long Island Sound to more offshore locations. Fall survey data, which included New York waters, also exhibited regional variation (Figure 2). The MADMF, RIDFW, CTDEP, and NYDEC had substantial numbers of fish in length classes less than 20 cm. In fact, the New York Peconic Bay survey contained few fish larger than 20 cm. Both the NMFS/NEFSC and

NJDEP survey had few fish smaller than 20 cm and more fish exceeding 40 cm. Again, these differences probably represent different spatial distributions and mortality rates by size.

Estimated proportions at age for B2 discards by state are given in Table 3. Most discarded fish are age 1 to 3. Massachusetts, Rhode Island, New York, and New Jersey had a few fish age 4. Connecticut had fish as old as 5 and 6 as a result of slow growth in the age samples from Western Long Island Sound. The extension of the discard age structure with size limit regulation is very clear in the New York estimates. Application of proportion at age estimates based on trawl survey lengths in sublegal classes to recreational B2 type catch will produce discards dominated by juvenile fish. This will produce more realistic discard estimates at age than the past practice of assuming that B2 proportion at age was similar to the A and B1 landed age structure. These discard estimates will be important in establishing selection patterns from VPA runs and estimating biological reference points.

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Table 1. Winter flounder length frequencies (in 1 cm size intervals) from spring trawl surveys in the New England and Mid-Atlantic region. Sample sizes standardized to NMFS.

Length (cm)	NMFS	MADMF	RIDFW	CTDEP	NJDEP	TOTAL
2	0	0	2	0	0	2
3	0	0	1	0	0	1
4	0	0	1	0	0	1
5	0	0	5	0	1	6
6	6	0	10	1	1	18
7	12	6	40	3	1	61
8	5	13	109	10	1	138
9	10	51	217	35	0	313
10	39	149	452	93	13	745
11	40	279	709	229	32	1288
12	53	379	876	456	62	1827
13	110	422	828	716	115	2191
14	104	400	666	855	210	2234
15	134	363	598	1034	287	2415
16	166	333	569	1056	363	2487
17	251	290	593	1093	403	2629
18	256	298	635	1055	428	2672
19	232	307	611	1028	457	2635
20	339	380	633	904	358	2615
21	436	428	521	795	413	2593
22	464	442	511	711	427	2555
23	708	507	441	605	487	2749
24	744	571	426	514	584	2839
25	812	593	456	442	732	3035
26	871	695	433	403	891	3293
27	993	661	454	324	982	3415
28	919	689	435	263	952	3258
29	757	650	367	216	843	2833
30	751	711	396	164	765	2788
31	594	598	313	126	889	2520
32	598	597	281	95	559	2130
33	440	502	243	72	540	1797
34	386	439	189	55	446	1516
35	353	396	142	41	332	1264
36	266	309	97	30	245	946
37	242	226	75	16	176	736
38	210	195	53	11	124	592
39	195	138	38	8	96	475
40	200	125	21	6	81	433
41	117	90	13	2	58	279
42	134	62	6	2	44	248
43	134	43	3	1	19	200
44	77	40	3	1	20	141
45	67	26	1	0	12	106
46	40	21	0	0	8	69
47	60	11	1	0	7	80
48	48	13	1	0	5	67
49	36	7	0	0	2	45
50	10	6	0	0	0	16
51	7	4	0	0	1	11
52	5	2	0	0	0	7
53	13	2	0	0	0	15
54	14	1	0	0	0	14
55	4	1	0	0	0	5
56	7	0	0	0	0	7
57	3	2	0	0	0	5
58	0	0	0	0	0	0
59	0	0	0	0	0	0
60	2	0	0	0	0	2
Total	12085	13472	13472	13472	13472	67360

Table 2. Winter flounder length frequencies (in 1 cm size intervals) from fall trawl surveys in the New England and Mid-Atlantic region. Sample sizes standardized to NMFS.

Length (cm)	NMFS	MADMF	RIDFW	CTDEP	NYDEC	NJDEP	TOTAL
2	0	0	0	0	13	0	13
3	0	0	1	0	26	0	27
4	0	0	7	0	397	0	404
5	0	16	42	0	755	0	812
6	20	0	151	0	1687	0	1858
7	25	6	296	2	1891	0	2221
8	15	9	462	18	2094	0	2589
9	53	59	520	25	1207	0	1857
10	20	86	370	62	691	0	1192
11	2	152	218	270	235	0	669
12	3	84	245	670	238	2	843
13	17	86	352	948	240	2	1368
14	1	171	545	1089	235	10	1909
15	16	138	749	1131	288	10	2289
16	63	284	966	1090	430	22	2895
17	108	609	1038	1079	406	45	3297
18	102	719	953	1026	381	50	3284
19	210	699	786	966	214	194	3129
20	305	683	702	826	161	256	3073
21	484	750	505	678	122	607	3295
22	558	587	427	515	100	588	2937
23	668	505	337	414	78	921	3025
24	781	460	392	310	37	1074	3158
25	745	477	297	230	33	1074	2936
26	759	516	299	198	32	904	2740
27	841	412	273	132	27	871	2620
28	831	593	235	105	22	775	2588
29	727	656	186	86	11	603	2287
30	793	623	190	57	8	572	2271
31	591	690	138	43	6	615	2096
32	611	618	118	36	5	421	1815
33	607	351	93	21	4	505	1596
34	462	320	67	19	2	385	1258
35	293	231	39	11	2	366	950
36	308	140	30	7	2	306	796
37	229	51	19	6	1	199	506
38	164	60	12	4	1	179	423
39	152	129	8	1	1	163	456
40	126	23	6	1	1	122	279
41	65	55	5	1	1	77	203
42	76	6	3	0	0	65	151
43	49	11	4	0	0	38	103
44	53	0	0	0	0	19	73
45	32	2	1	0	0	12	47
46	31	9	0	0	0	22	61
47	8	0	0	0	0	5	13
48	15	6	0	0	0	2	23
49	6	0	0	0	0	7	13
50	19	0	0	0	0	0	19
51	7	0	0	0	0	0	7
52	25	2	0	0	0	0	27
53	1	0	0	0	0	0	1
54	0	0	0	0	0	0	0
55	6	0	0	0	0	0	6
56	2	0	0	0	0	0	2
57	0	0	0	0	0	0	0
58	3	0	0	0	0	0	3
59	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0
Total	12085	12085	12085	12085	12085	12085	67360

Table 3. Proportion at age estimates for B2 discarded recreational winter flounder from state trawl and age-length keys.

Massachusetts

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.012	0.048	0.180	0.088	0.081	0.130	0.344	0.228	0.267
2	0.408	0.307	0.361	0.335	0.383	0.557	0.401	0.588	0.478
3	0.550	0.627	0.440	0.576	0.517	0.295	0.251	0.179	0.255
4	0.030	0.019	0.020	0.000	0.018	0.019	0.004	0.005	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Rhode Island

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.107	0.104	0.097	0.118	0.206	0.120	0.419	0.125	0.464
2	0.893	0.586	0.569	0.604	0.563	0.496	0.384	0.614	0.461
3	0.000	0.310	0.327	0.278	0.232	0.349	0.195	0.256	0.075
4	0.000	0.000	0.007	0.000	0.000	0.035	0.002	0.006	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Connecticut

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.010	0.075	0.099	0.097	0.075	0.071	0.052	0.110	0.166
2	0.252	0.489	0.668	0.590	0.598	0.590	0.525	0.626	0.524
3	0.705	0.258	0.159	0.285	0.282	0.288	0.406	0.199	0.272
4	0.034	0.166	0.040	0.026	0.045	0.052	0.013	0.059	0.032
5	0.000	0.014	0.035	0.000	0.000	0.002	0.005	0.005	0.006
6	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

New York

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.006	0.086	0.140	0.182	0.159	0.070	0.102	0.137	0.198
2	0.507	0.674	0.766	0.728	0.754	0.724	0.682	0.717	0.649
3	0.488	0.212	0.090	0.087	0.088	0.206	0.216	0.133	0.136
4	0.000	0.027	0.004	0.003	0.000	0.000	0.000	0.014	0.015
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

New Jersey

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.013	0.105	0.124	0.032	0.061	0.026	0.066	0.031	0.150
2	0.418	0.572	0.740	0.618	0.777	0.672	0.664	0.542	0.569
3	0.569	0.262	0.124	0.328	0.162	0.301	0.270	0.317	0.224
4	0.000	0.061	0.012	0.022	0.000	0.000	0.000	0.000	0.058
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

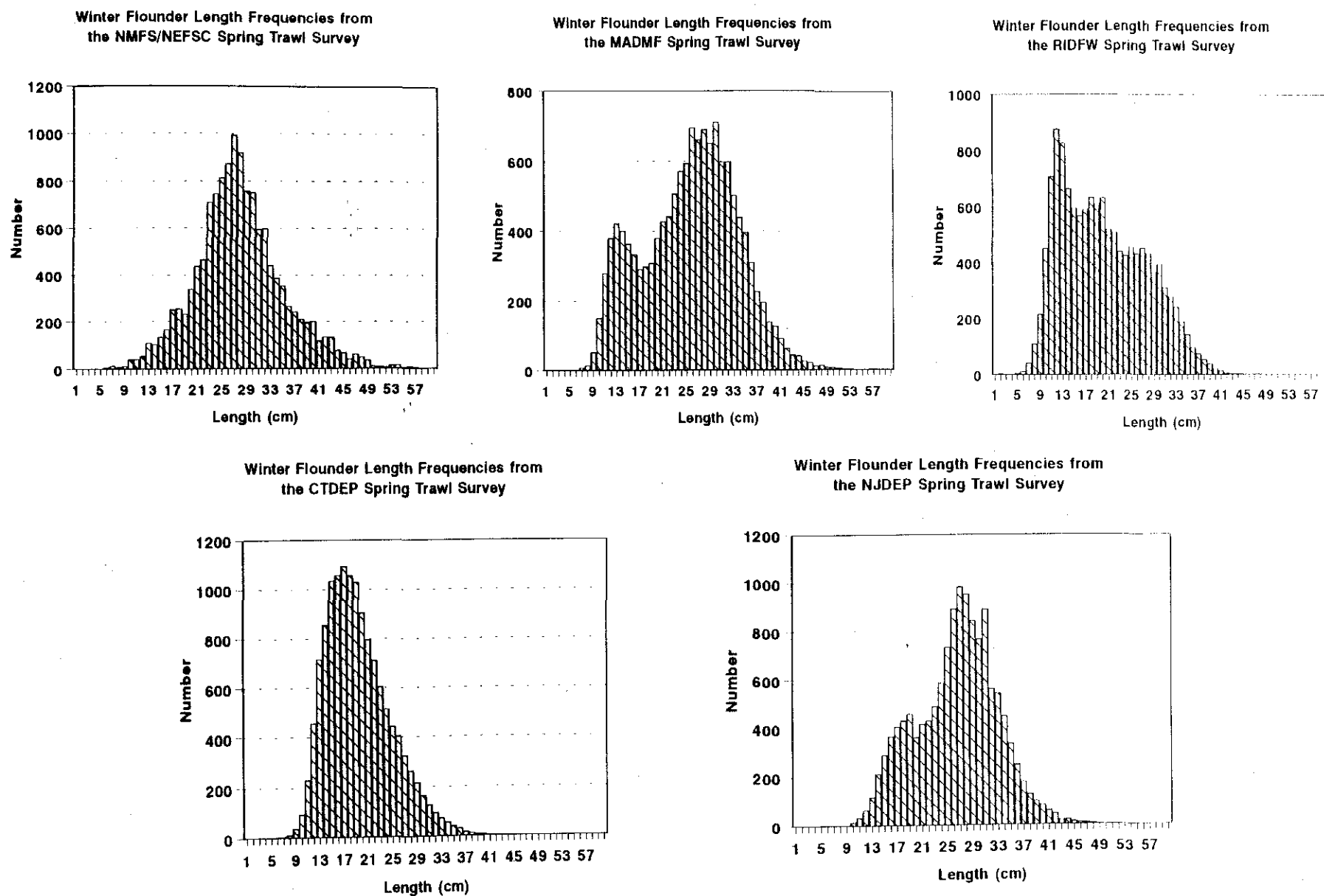


Figure 1. Length frequencies from spring trawl surveys in Southern New England/Mid-Atlantic.

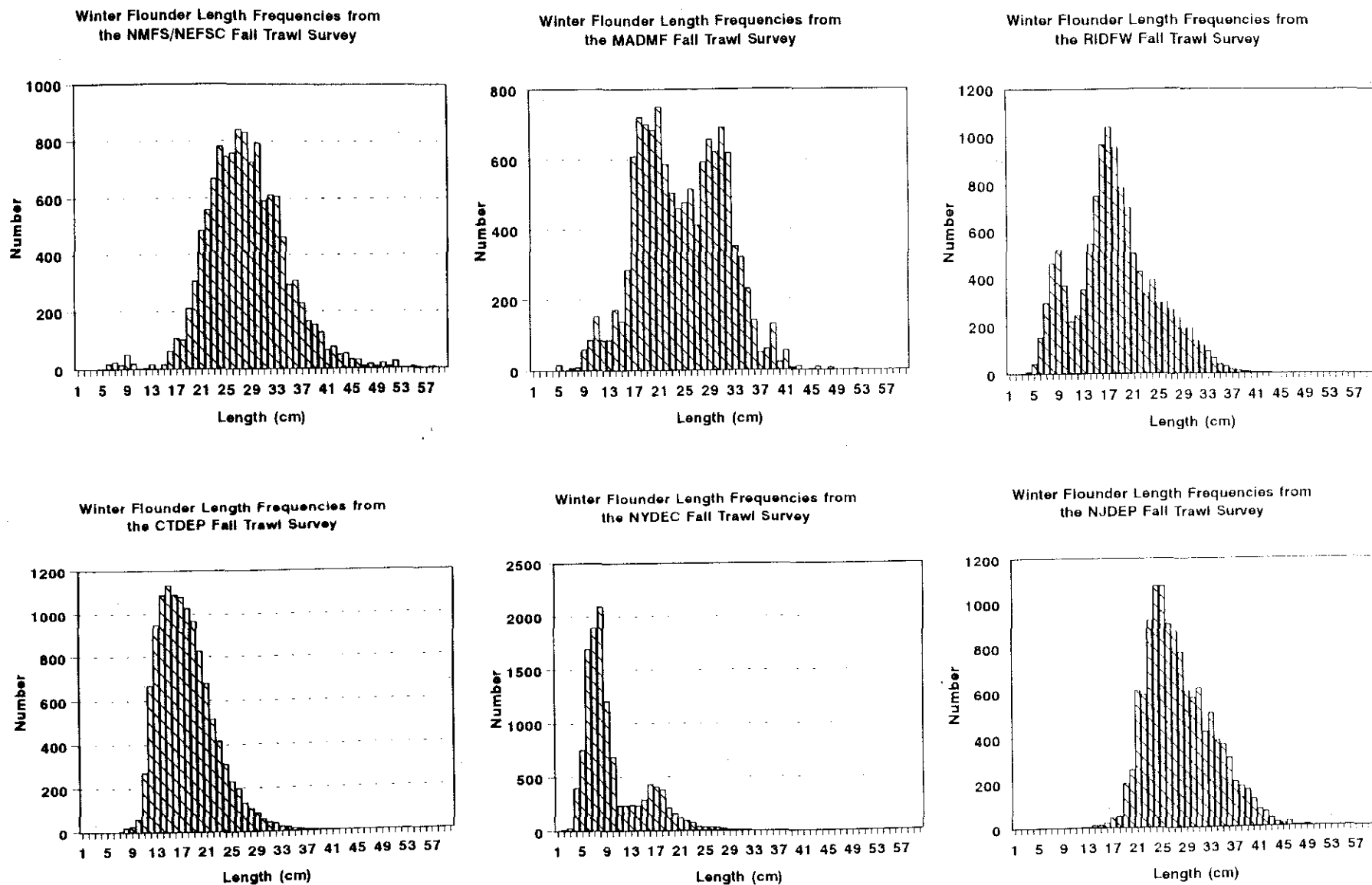


Figure 2. Length frequencies of fall trawl surveys in Southern New England / Mid-Atlantic area.

Appendix III. A Priori Evaluation of Fishery-Independent Indices
for the Winter Flounder Assessment

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Introduction

Fishery independent indices are used in VPA analysis to estimate either terminal F or terminal populations in the final year of the VPA. Tuning affects population and mortality estimates through the unconverged portion of the VPA. In addition, the coherency of the tuning indices affects the precision of the terminal estimates.

Eleven different state and federal survey indices are age-disaggregated into 62 potential tuning indices. These surveys vary in areal coverage, seasonality, survey methodology and time-series length. Evaluation of the coherency of these indices before tuning may be useful in interpreting diagnostics from a VPA analysis and reducing coefficients of variation in estimates.

The NMFS spring and fall surveys have the widest geographic coverage but age specific abundance indices are only available from 1985 onwards. Connecticut, Rhode Island and Massachusetts cover inshore coastal waters and have a slightly longer time-series. The age zero surveys (MA seine, DEL trawl, NY Peconic Bay Trawl, and RI trawl) cover relatively small areas and vary in longevity.

Methods and Materials

Eleven fishery independent surveys were available for analysis (Table 1). Age-disaggregated indices were visually examined for contrast and presence of years with zero catches. Age-disaggregated survey indices were transformed to z-scores and plotted to assist in visually evaluating indices for coherency (Figure 1-16). Pairwise correlation analyses among surveys by age were performed on indices from 9 of the 11 surveys. The New Jersey trawl survey and Connecticut embayment young-of-the-year surveys were not included in the analysis because of small sample sizes ($N=3$ and 4 , respectively). Correlation analyses were also performed on log-transformed data with years with "zero" data excluded from the analysis. Age 0 indices were advanced one year and one age, and were tested for correlations with age 1 indices. Correlation analyses using the NMFS Fall survey indices were examined for both actual year and age indices and the indices advanced one year and one age. The NMFS Fall survey and NMFS Fall survey advanced an age and a year were not tested for correlation. Two tailed significance of correlation was tested at the ($p=.05$) level and probability of significance was not adjusted for multiple comparisons.

Two way ANOVAs testing for year and cohort effects with no interactions were run with all CT, RI, NMFS spring, NMFS Fall, and MA spring z-score indices except age 0. Two way ANOVAs were also run for RI and MA for years using a pooled age-length key (1978-1989) and annual keys (1990-1994). The following indices were excluded from the analysis because of a general lack of contrast in the indices: CT (ages 8-10), RI (ages 8-10), NMFS spring (ages 6-8), NMFS fall (ages 5-7) and MA (age 8).

Results and Discussion

The Connecticut indices for ages 8-10 have zero catches and indices for ages 10 and 11 show little contrast. The Rhode Island trawl indices for ages 7-10 have years that contain zero catches and the age 8-10 indices show little contrast after 1988. The NMFS spring indices for ages 7-8 have years that contain zero catches and ages 6-8 show little contrast. As well, NMFS fall indices for ages 5, 6, and 7 also have years with zero catches and show little contrast. The Mass age 8 index has years with zero catches and has little contrast after 1990. The above mentioned indices may not be useful for tuning with the exception of possibly using a series truncated to earlier years when the index showed more contrast.

Results from the correlation analyses are shown in Appendix Tables 1 and 2. Of the 145 paired comparisons with untransformed indices, only 18 significant positive correlations were detected (Tables 2 and 3). Based upon the number of positive correlations, the CT, RI, and MA surveys produced the most coherent indices. The NMFS fall age 1 index was negatively correlated with the MA age 0 index. Ages with the most coherency were age 4 and age 7+. No significant correlations were found in ages 3, 6, 9 and 10.

Transforming the data reduced the number of significant correlations to 14 (Tables 4 and 5). Nine correlations that were significant before transformation were not significant after transformation. Four insignificant correlations were significant after ln transformation. The most coherent surveys were the RI and CT. Ages with the most coherency were age 4, 7+ and 7.

The results of the correlation analysis should be interpreted with caution because of the small sample sizes involved and the collinear downward trend in some of the indices. Positive correlation, particularly in the older indices, may arise from the collinearity rather than coherency in cohort strength.

Plots of surveys z-score indices by age and survey are provided and may help interpret coherency among surveys. Examination of z-score plots for RI and Mass indices suggest the presence of strong year effects but the ability to track cohort strength was not apparent. Results from two-way ANOVAs using year and cohort main effects are shown in Table 6. Results from the two way ANOVA analyses indicate that the RI and NMFS spring survey do **not contain** significant cohort effects and suggest that they may not be useful as a tuning indices. The inability to detect cohorts may be a function of large inter-annual availability effects, very high mortality rates or, in the case of RI, use of a pooled key age-length key. The results from testing the Mass survey for years using the pooled key and annual keys suggest that the pooled keys may remove cohort effects. A significant cohort effect was not found for RI data for the years using annual keys.

Table 1. Fishery independent surveys.

Survey	Abbreviation	Years in tables	N	Ages	First Age (Year) with catch = 0
IT strapping		80-84	4	0	
IT inter-trawl	IT_0	88-94	6	0	
Del	DEL_0	86-94	8	0	
Ma seine	MA_0	75-95	21	0	
CT trawl	CT	84-94	11	1-11	age 8, 1990
RI trawl	RI	79-95	17	0-10	age 7, 1992
NMFS spring	NSP	85-94	10	1-8	age 7, 1992
NMFS fall	NSF	85-94	10	1-7	age 5, 1993
NMFS fall A*	NFA	86-95	10	2-9	age 6, 1994
Ma spring	MA	78-94	17	1-8	age 8, 1990
NY Peconic	NY_0	85, 87-94	9	0	
NY Peconic	NY_1	85, 87-94	9	1	
NJ trawl		93-95	3	1-11	age 9, 1992

* NMFS fall A is the NMFS fall survey advanced 1 age and 1 year.

Table 2. Number of significant correlations among trawl survey indices, ages 0-10. +: number of positive correlations, -: number of negative correlations.

	CT_0	RI_0	DEL_0	MA_0	NY_0	CT	RI	NSP	MA	NSF	NY1	NFA	TOTAL
CT_0	X	0	0	0	0	0	0	0	0	0	0	X	0
RI_0	0	X	0	1+	0	0	1+	0	0	0	0	X	2+
DEL_0	0	0	X	0	0	0	0	0	0	0	0	X	0
MA_0	0	1+	0	X	0	0	0	0	0	-1	0	X	1+, -1
NY_0	0	0	0	0	X	0	0	0	1	0	1+	X	2+
CT	0	0	0	0	0	X	3+	2+	3+	0	0	X	8+
RI	0	1+	0	0	0	3+	X	0	3+	0	0	0	7+
NSP	0	0	0	0	0	2+	0	X	0	1+	1+	0	4+
MA	0	0	0	0	1+	3+	3+	0	X	0	0	1+	8+
NSF	0	0	0	-1	0	0	0	1+	0	X	0	X	1+, -1
NY_1	0	0	0	0	1	0	0	1+	0	0	X	X	2+
NFA	X	X	X	X-	X	0	0	0	1+	X	X	X	1+
Total	0	2+	0	1+, -1	2+	8+	7+	4+	8+	1+, -1	2+	1+	

Table 3. Number of significant correlations among indices by age.

age	0-1	0	1	2	3	4	5	6	7	8	9	10	7+
positive	3	1	1	1	0	4	2	0	2	1	0	0	3
negative	1	0	0	0	0	0	0	0	0	0	0	0	0
N	30	10	15	14	14	14	14	14	7	3	3	1	6

Table 4. Number of significant correlations among log-transformed trawl survey indices, ages 1-10. +: number of positive correlations, -: number of negative correlations.

	CT_1	RI_1	DEL_1	MA_1	NY_1	CT	RI	NSF	MA	NSF	NY_1	NFA	TOTAL
CT_1	X	0	0	0	0	0	1	0	0	0	0	X	0
RI_1	0	X	0	1+	0	0	1+	0	0	0	0	X	2+
DEL_1	0	0	X	0	0	0	0	0	0	0	0	X	0
MA_1	0	1+	0	X	0	0	1+	0	0	0	0	X	2+
NY_1	0	0	0	0	X	0	0	0	1+	0	0	X	1+
CT	0	0	0	0	0	X	4+	2+	0	0	0	0	6+
RI	0	1+	0	1+	0	4	X	1+	3+	0	0	0	10+
NSF	0	0	0	0	0	2+	1+	X	0	0	0	0	3+
MA	0	0	0	0	1+	0	3+	0	X	0	0	0	4+
NSF	0	0	0	0	0	0	0	0	0	X	0	X	0
NY_1	0	0	0	0	0	0	0	0	0	0	X	X	0
NFA	X	X	X	X	X	0	0	0	0	X	X	X	0
TOTAL	0	2+	0	2+	1+	6+	10+	3+	4+	0	0	0	

Table 5. Number of significant correlations among log-transformed indices by age.

age	0-1	0	1	2	3	4	5	6	7	8	9	10	7+
positive	3	1	0	0	1	2	1	0	3	1	0	0	2
negative	0	0	0	0	0	0	0	0	0	0	0	0	0
N	30	10	15	14	14	14	14	14	7	3	3	1	6

Table 6. Summary of two way ANOVA testing year and yearclass main effects with no interactions on Z-transformed survey indices. *: significant ($P < .05$); ns: not significant.

Survey	Year effect	Cohort effect
CT	*	*
RI	*	ns
NMFS spring	*	ns
NMFS fall	*	*
MA spring (78-94)	*	*
MA spring (78-89)	*	ns
MA spring (90-94)	ns	*
RI (78-89)	*	ns
RI (90-95)	*	ns

Appendix I: Table 1. Winter flounder survey indices correlation analysis using untransformed data. * - Signif. LE 0.05. ** - Signif. LE 0.01 (2-tailed). "." printed if a coefficient cannot be computed.

Age 0 and 1 indices

- - Correlation Coefficients - -

	CT_0	RI_0	DEL_0	MA_0	NY_0
CT_0	1.0000	.1322	-.3131	-.5035	.1503
RI_0	.1322	1.0000	.0588	.5846*	.5812
DEL_0	-.3131	.0588	1.0000	.4338	.1418
MA_0	-.5035	.5846*	.4338	1.0000	-.0816
NY_0	.1503	.5812	.1418	-.0816	1.0000
CT1	.4028	-.1185	.0807	.0322	.4722
RI1	.3427	.5123*	.1575	.3954	-.2771
NSP1	-.5228	-.0315	.1937	.2071	.0954
MA1	.1342	-.1941	-.2331	-.0445	.8626**
NSF1	.5968	.0276	-.3137	-.6582*	.6433
NY1	.4643	.2457	.3961	-.2060	.8054*

Age 0 and 1 indices continued

	CT1	RI1	NSP1	MA1	NSF	NY1
CT_0	.4028	.3427	-.5228	.1342	.5968	.4643
RI_0	-.1185	.5123*	-.0315	-.1941	.0276	.2457
DEL_0	.0807	.1575	.1937	-.2331	-.3137	.3961
MA_0	.0322	.3954	.2071	-.0445	-.6582*	-.2060
NY_0	.4722	-.2771	.0954	.8626**	.6433	.8054*
CT1	1.0000	-.2041	-.3076	.1873	.2376	.4909
RI1	-.2041	1.0000	-.1891	-.0919	-.4031	-.1226
NSP1	-.3076	-.1891	1.0000	-.0767	-.0468	-.1544
MA1	.1873	-.0919	-.0767	1.0000	.5917	.4117
NSF	.2376	-.4031	-.0468	.5917	1.0000	.6804*
NY1	.4909	-.1226	-.1544	.4117	.6804*	1.0000

Age 2 indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA	NSF
CT	1.0000	-.2205	.0244	.1863	-.1682	-.0388
RI	-.2205	1.0000	.3003	.1435	-.0522	-.3569
NSP	.0244	.3003	1.0000	.0974	-.1171	.2392
NFA	.1863	.1435	.0974	1.0000	.6688*	.
MA	-.1682	-.0522	-.1171	.6688*	1.0000	.2347
NSF	-.0388	-.3569	.2392	.	.2347	1.0000

Age 3 indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA	NSF
CT	1.0000	.8880	.8808	-.0048	-.0476	.0374
RI	.8880	1.0000	.8003	-.0912	.0768	-.0388
NSP	.8808	.8003	1.0000	-.3264	.1378	.0698
NFA	-.0048	-.0912	-.3264	1.0000	.0010	
MA	-.0476	.0768	.1378	.0010	1.0000	-.0218
NSF	.0374	-.0388	.0698		-.0218	1.0000

Age 4 indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA	NSF
CT	1.0000	.7049*	.8269**	.1437	.6922*	-.1656
RI	.7049*	1.0000	.4745	.0989	.5687*	-.0949
NSP	.8269**	.4745	1.0000	.2135	.3528	.3042
NFA	.1437	.0989	.2135	1.0000	-.1319	
MA	.6922*	.5687*	.3528	-.1319	1.0000	.2109
NSF	-.1656	-.0949	.3042		.2109	1.0000

Age 5 indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA	NSF
CT	1.0000	.5371	.0368	-.0437	.3653	-.2681
RI	.5371	1.0000	.4441	-.0234	.6936**	.1831
NSP	.0368	.4441	1.0000	.5275	.4852	.8347**
NFA	-.0437	-.0234	.5275	1.0000	.0397	
MA	.3653	.6936**	.4852	.0397	1.0000	.4280
NSF	-.2681	.1831	.8347**		.4280	1.0000

Age 6 indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA	NSF
CT	1.0000	.3015	-.0114	-.2566	-.4509	-.4362
RI	.3015	1.0000	.2861	.3751	.4463	-.4124
NSP	-.0114	.2861	1.0000	.5920	.2954	-.2500
NFA	-.2566	.3751	.5920	1.0000	.1052	
MA	-.4509	.4463	.2954	.1052	1.0000	.4345
NSF	-.4362	-.4124	-.2500		.4345	1.0000

Age 7 indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA
CT	1.0000	.8729	.8417**	.	.7184*
RI	.8729	1.0000	.1726	-.0673	.4418
NSP	.8417**	.1726	1.0000	.	.2517
NFA	.	-.0673	.	1.0000	.
MA	.7184*	.4418	.2517	.	1.0000

Age 8 indices

- - Correlation Coefficients - -

	CT	RI	MA
CT	1.0000	.8780**	.7326
RI	.8780**	1.0000	.4097
MA	.7326	.4097	1.0000

Age 9 indices

- - Correlation Coefficients - -

	CT	RI	MA
CT	1.0000	.3873	.1290
RI	.3873	1.0000	.1909
MA	.1290	.1909	1.0000

Age 10 indices

- - Correlation Coefficients - -

	CT	RI
CT	1.0000	-.2843
RI	-.2843	1.0000

Age 7+ indices

- - Correlation Coefficients - -

	CT	RI	NSP	MA
CT	1.0000	.8556**	.5780	.7600**
RI	.8556**	1.0000	.2463	.5063*
NSP	.5780	.2463	1.0000	.3639
MA	.7600**	.5063*	.3639	1.0000

Appendix Table 2. Winter flounder survey indices correlation analysis using log-transformed data. * - Signif. LE .05, ** - Signif. LE .01 (2-tailed), " . " printed if a coefficient cannot be computed.

Age 1 and 2 transformed indices

- - Correlation Coefficients - -

	CT_0	RI_0	DEL_0	MA_0	NY_0	
CT_0	1.0000	-.2463	-.3383	-.4284	.1101	
RI_0	-.2463	1.0000	.2070	.6245**	.1386	
DEL_0	-.3383	.2070	1.0000	.4690	.3669	
MA_0	-.4284	.6245**	.4690	1.0000	-.2286	
NY_0	.1101	.1386	.3669	-.2286	1.0000	
CT1	.2282	-.2909	.2214	-.0611	.2362	
RI1	.1612	.5472*	.4786	.5518*	-.4156	
NSP1	-.5673	.0671	.1994	.0889	.3502	
MA1	.1484	-.1246	-.0527	-.1066	.7439*	
NSF1	.8099	-.1617	-.4166	-.5304	.4037	
NY1	.4243	-.0171	.3085	-.2665	.5611	
	CT1	RI1	NSP1	MA1	NSF1	NY1
CT_0	.2282	.1612	-.5673	.1484	.8099	.4243
RI_0	-.2909	.5472*	.0671	-.1246	-.1617	-.0171
DEL_0	.2214	.4786	.1994	-.0527	-.4166	.3085
MA_0	-.0611	.5518*	.0889	-.1066	-.5304	-.2665
NY_0	.2362	-.4156	.3502	.7439*	.4037	.5611
CT1	1.0000	.0185	-.3333	-.0191	.0483	.4211
RI1	.0185	1.0000	-.1498	-.1764	-.4138	.1549
NSP1	-.3333	-.1498	1.0000	.0904	.1494	-.0003
MA1	-.0191	-.1764	.0904	1.0000	.3048	.0439
NSF1	.0483	-.4138	.1494	.3048	1.0000	.5865
NY1	.4211	.1549	-.0003	.0439	.5865	1.0000

Age 2 transformed indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA	NSF
CT	1.0000	.1307	.2241	-.0941	-.3146	.0073
RI	.1307	1.0000	.4821	.1720	-.0706	-.3068
NSP	.2241	.4821	1.0000	-.0914	-.1622	.3280
NFA	-.0941	.1720	-.0914	1.0000	.6410	.4069
MA	-.3146	-.0706	-.1622	.6410	1.0000	.0833
NSF	.0073	-.3068	.3280	.4069	.0833	1.0000

Age 3 transformed indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA	NSF
CT	1.0000	.8891	.8816	-.1831	-.4333	-.1847
RI	.8891	1.0000	.8016**	-.1488	.2819	-.1267
NSP	.8816	.8016**	1.0000	-.3032	-.1823	.2101
NFA	-.1831	-.1488	-.3032	1.0000	-.1914	-.1248
MA	-.4333	.2819	-.1823	-.1914	1.0000	-.0250
NSF	-.1847	-.1267	.2101	-.1248	-.0250	1.0000

Age 4 transformed indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA	NSF
CT	1.0000	.6367*	.8921**	.1802	.3378	-.2441
RI	.6367*	1.0000	.5989	-.1055	.4181	-.0487
NSP	.8921**	.5989	1.0000	.1717	.0970	.0960
NFA	.1802	-.1055	.1717	1.0000	-.1954	-.5794
MA	.3378	.4181	.0970	-.1954	1.0000	.0201
NSF	-.2441	-.0487	.0960	-.5794	.0201	1.0000

Age 5 transformed indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA	NSF
CT	1.0000	.5731	.1382	-.0881	.0131	-.4629
RI	.5731	1.0000	.5302	-.1762	.5465*	-.0029
NSP	.1382	.5302	1.0000	.5168	.4488	.4689
NFA	-.0881	-.1762	.5168	1.0000	.0233	-.2913
MA	.0131	.5465*	.4488	.0233	1.0000	.4059
NSF	-.4629	-.0029	.4689	-.2913	.4059	1.0000

Age 6 transformed indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA	NSF
CT	1.0000	.5383	.1264	-.0655	-.5506	-.4086
RI	.5383	1.0000	.4950	.2110	.3219	-.2540
NSP	.1264	.4950	1.0000	.2224	.1133	-.2500
NFA	-.0655	.2110	.2224	1.0000	.2549	
MA	-.5506	.3219	.1133	.2549	1.0000	.3948
NSF	-.4086	-.2540	-.2500		.3948	1.0000

Age 7 transformed indices

- - Correlation Coefficients - -

	CT	RI	NSP	NFA	MA
CT	1.0000	.6424*	.7667*	.	.5540
RI	.6424*	1.0000	.3648	.1920	.5669*
NSP	.7667*	.3648	1.0000	.	.2072
NFA	.	.1920	.	1.0000	.
MA	.5540	.5669*	.2072	.	1.0000

Age 8 transformed indices

- - Correlation Coefficients - -

	CT	RI	MA
CT	1.0000	.8658**	.7347
RI	.8658**	1.0000	.5581
MA	.7347	.5581	1.0000

Age 9 transformed indices

- - Correlation Coefficients - -

	CT	RI	MA
CT	1.0000	.6294	.5864
RI	.6294	1.0000	.2698
MA	.5864	.2698	1.0000

Age 10 transformed indices

- - Correlation Coefficients - -

	CT	RI
CT	1.0000	-.2563
RI	-.2563	1.0000

Age 7+ transformed indices

- - Correlation Coefficients - -

	CT	RI	NSP	MA
CT	1.0000	.7268*	.5304	.4008
RI	.7268*	1.0000	.5862	.6584**
NSP	.5304	.5862	1.0000	.4104
MA	.4008	.6584**	.4104	1.0000

Age Zero Indices Z-scores

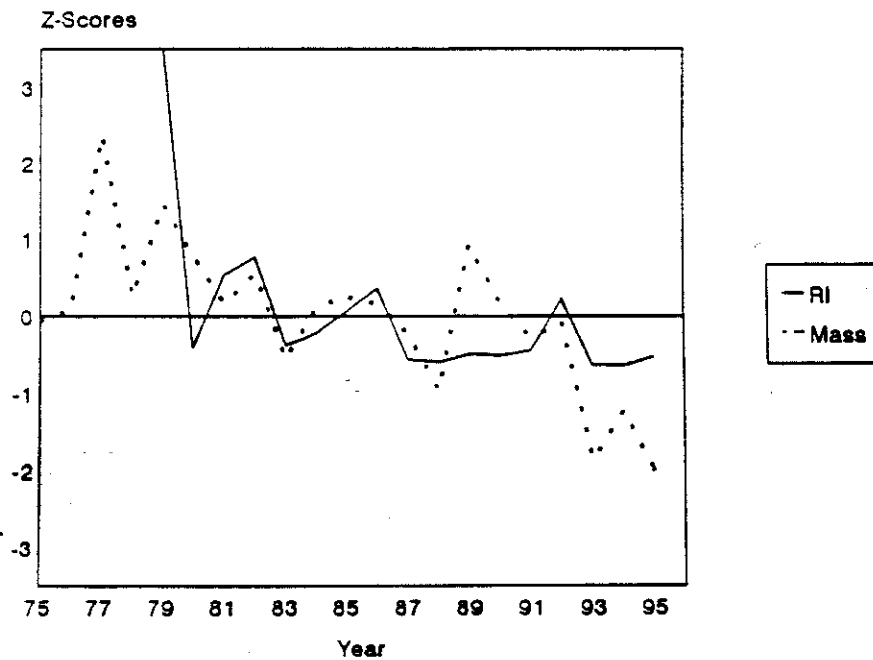
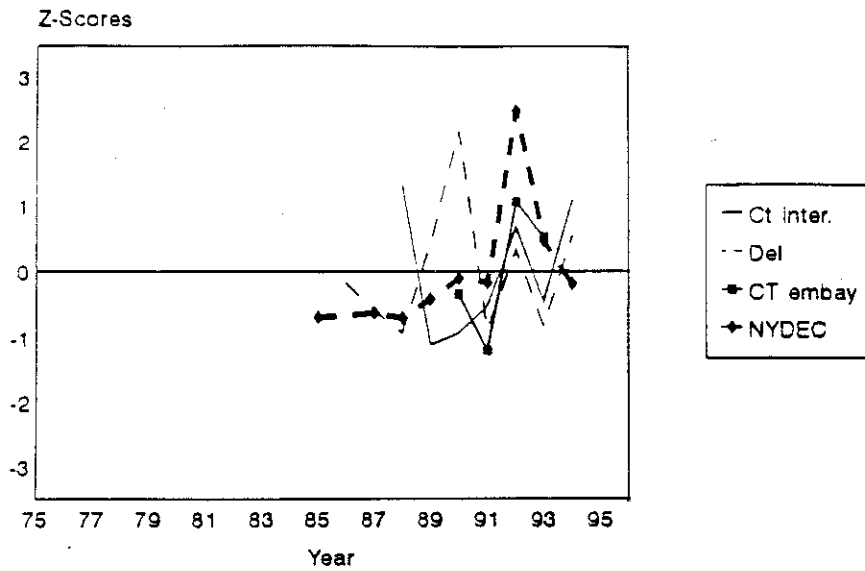


Figure 1. Standardized age zero winter flounder survey indices for coastal Connecticut, Delaware, Connecticut bays, New York, Rhode Island and Massachusetts.

Age One Indices Z-scores

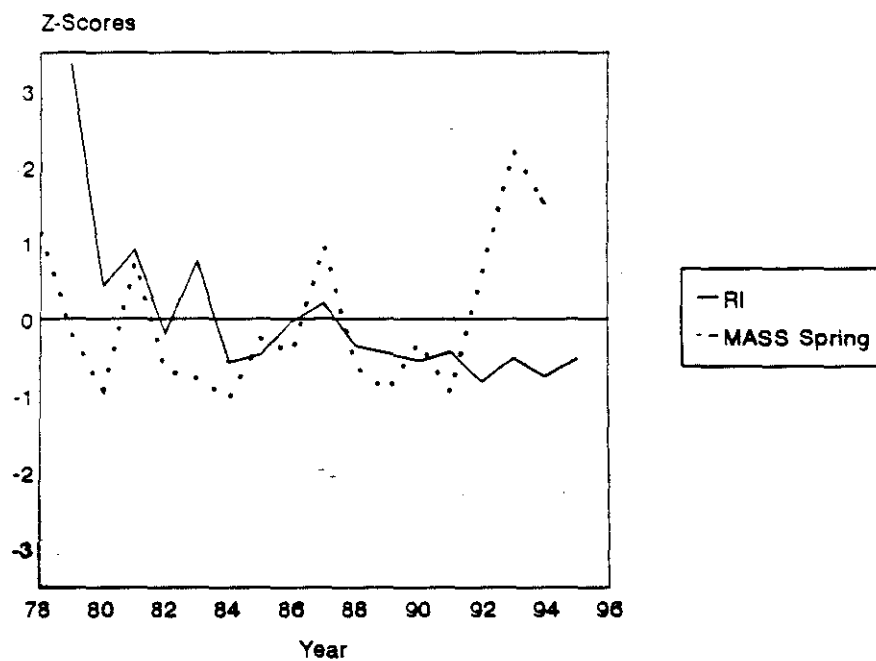
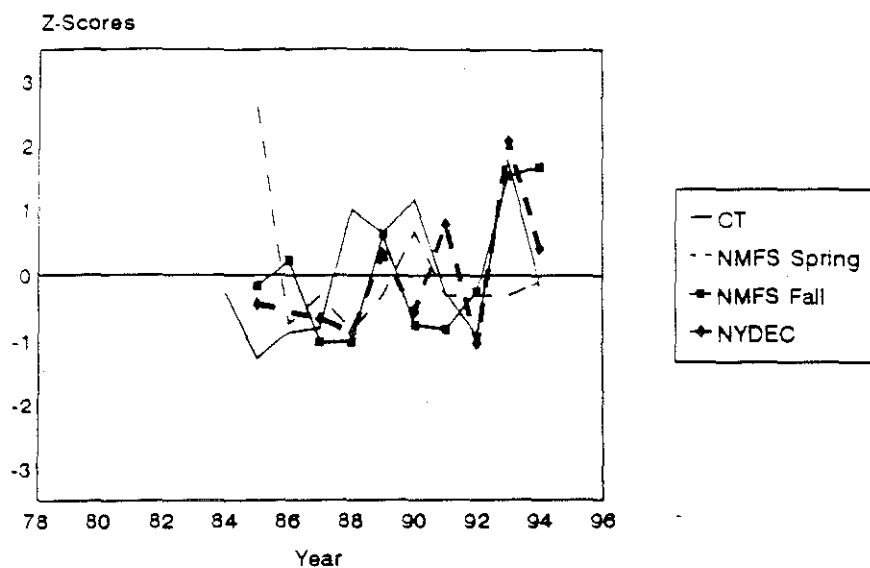


Figure 2. Standardized age one winter flounder survey indices for Connecticut, NMFS spring and fall, New York, Rhode Island and Massachusetts.

Age Two Indices Z-scores

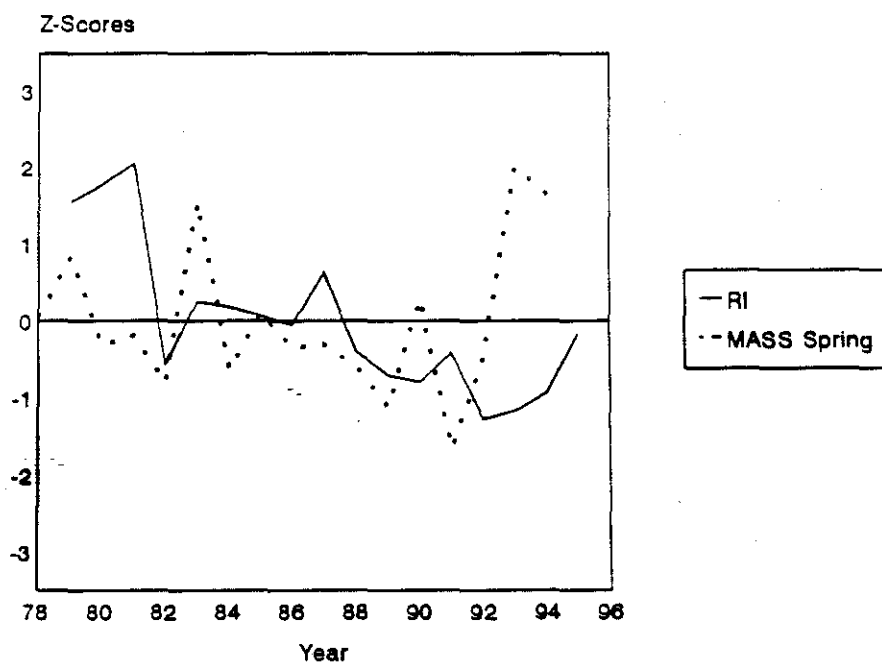
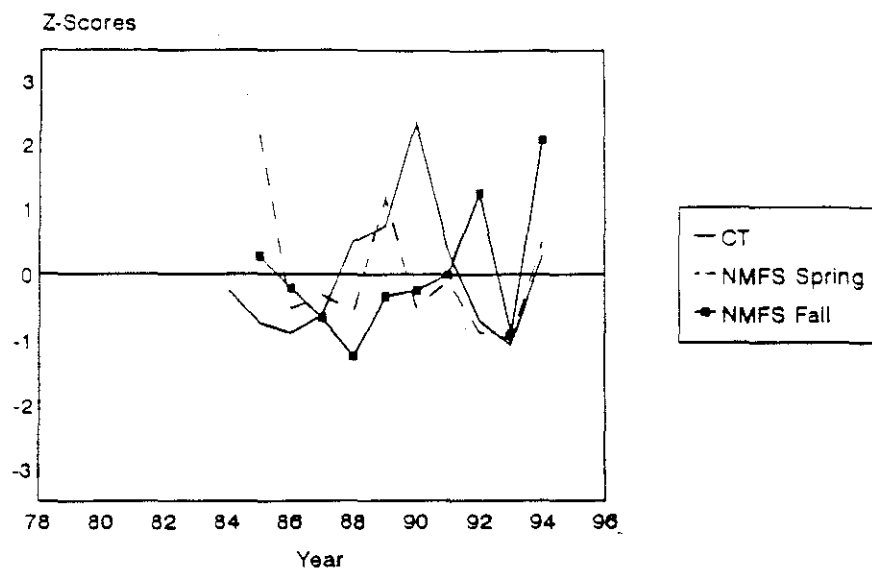


Figure 3. Standardized age two winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island and Massachusetts.

Age Three Indices Z-scores

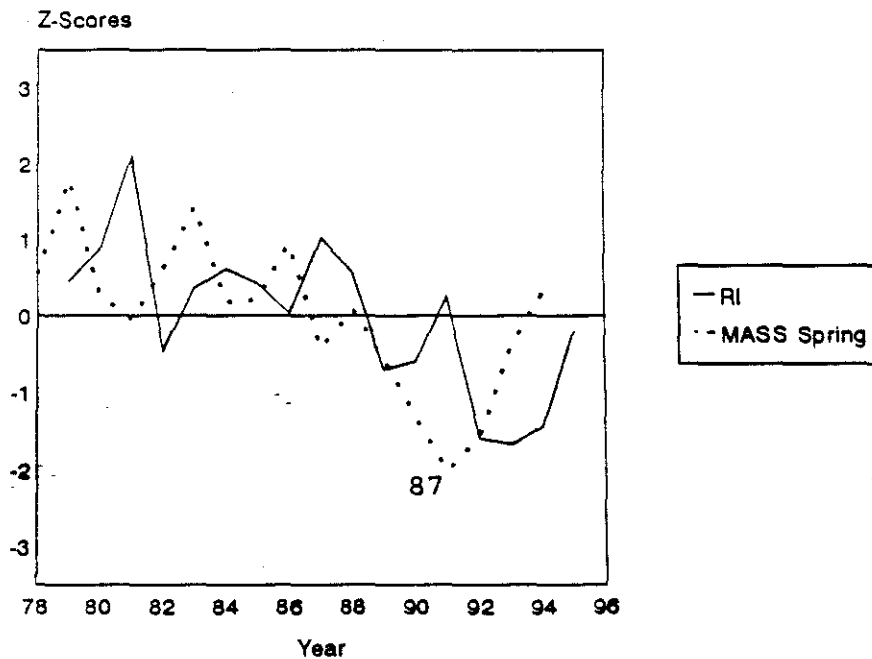
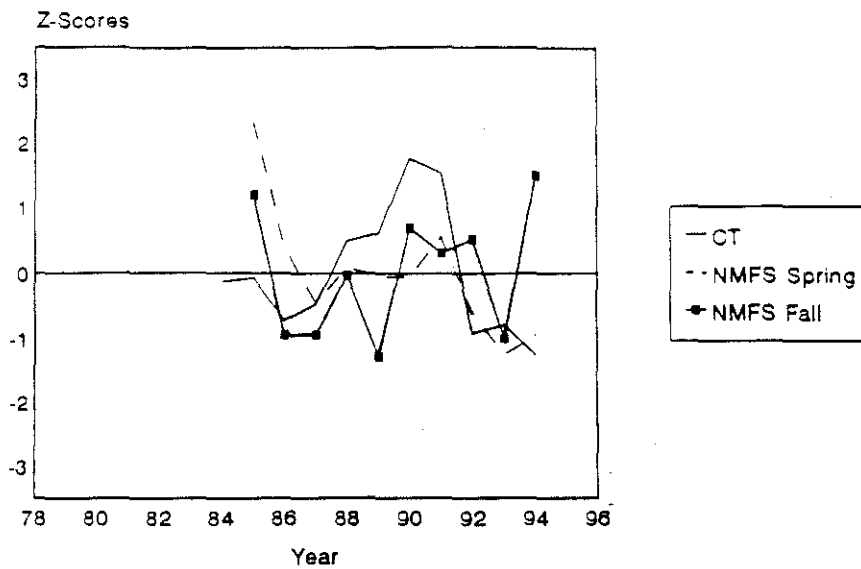


Figure 4. Standardized age three winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island and Massachusetts.

Age Four Indices Z-scores

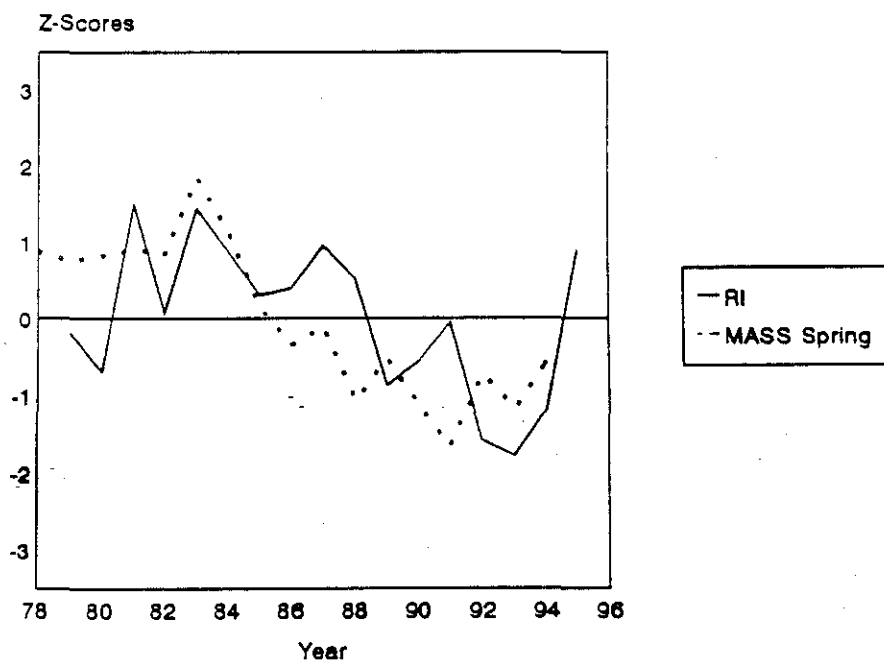
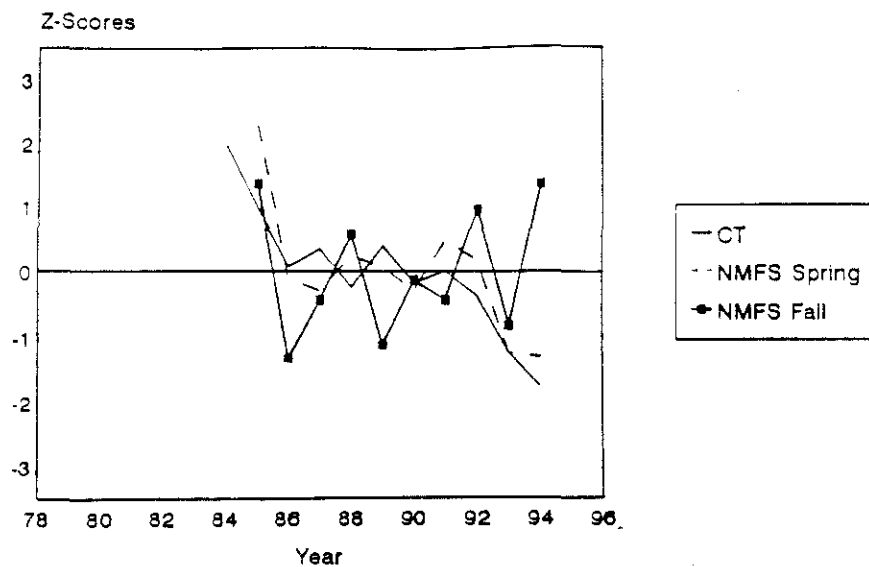


Figure 5. Standardized age four winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island and Massachusetts.

Age Five indices Z-scores

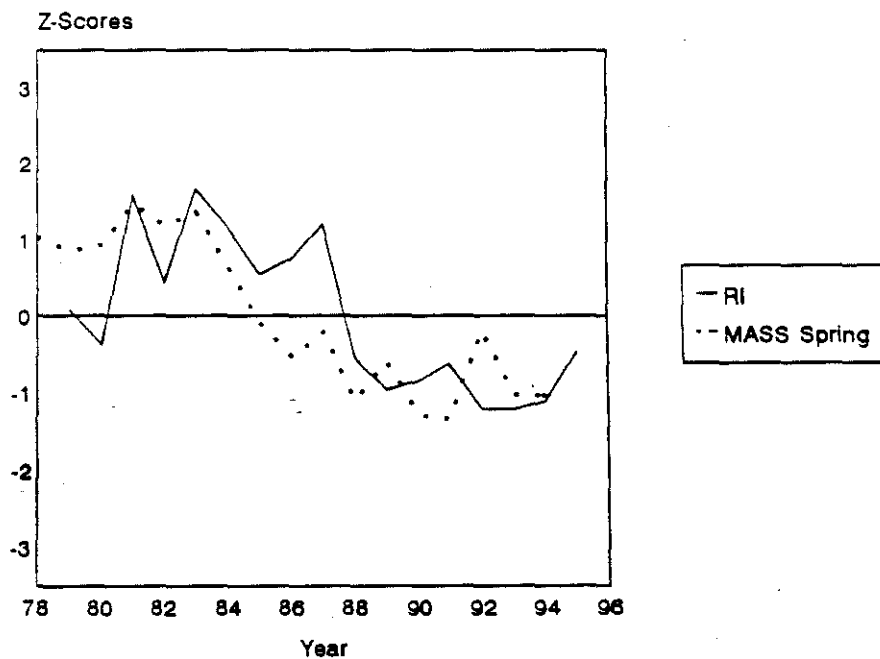
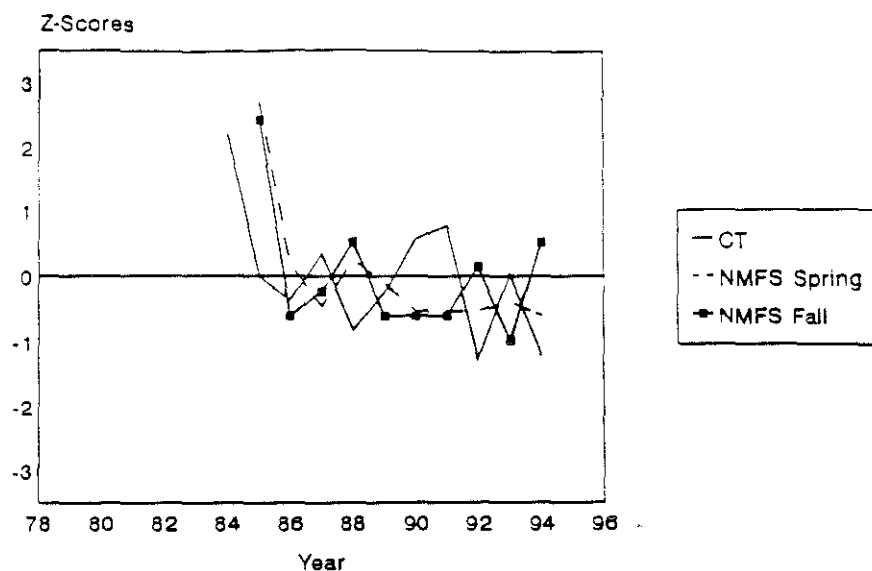


Figure 6. Standardized age five winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island and Massachusetts.

Age Six indices
Z-scores

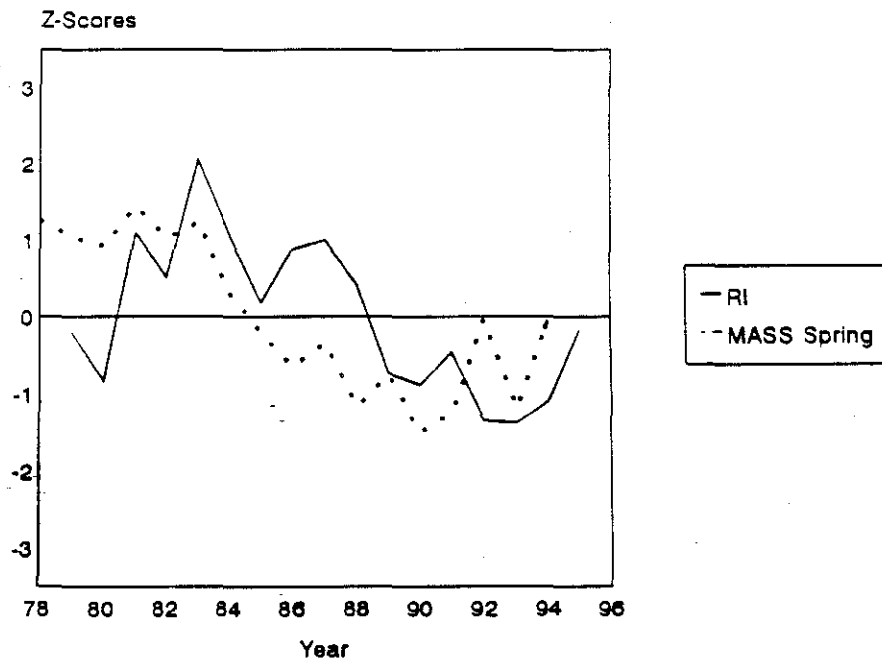
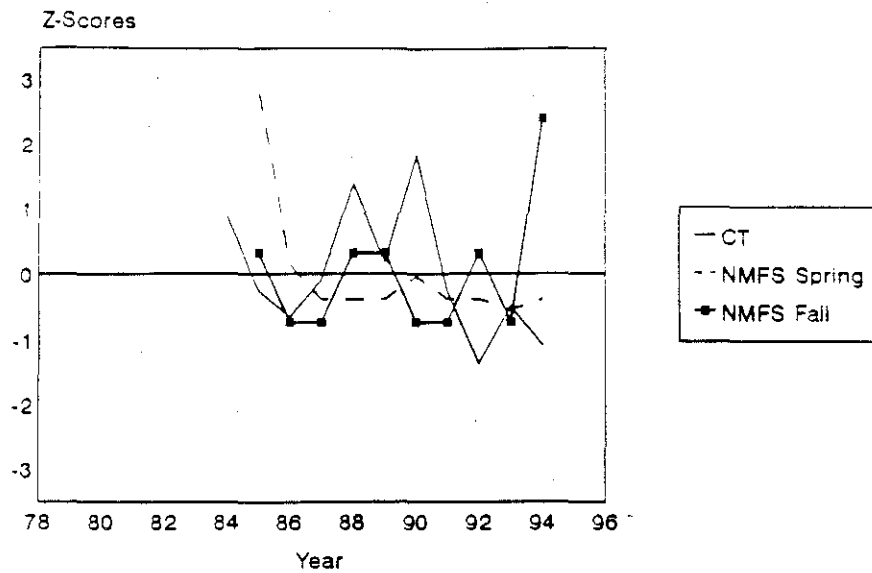


Figure 7. Standardized age six winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island, Massachusetts.

Age Seven Indices
Z-scores

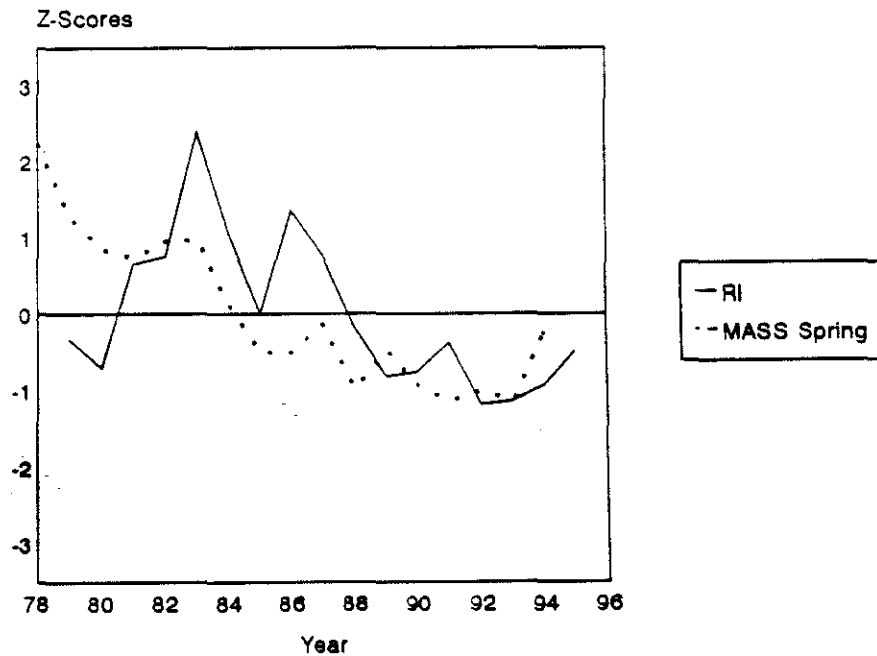
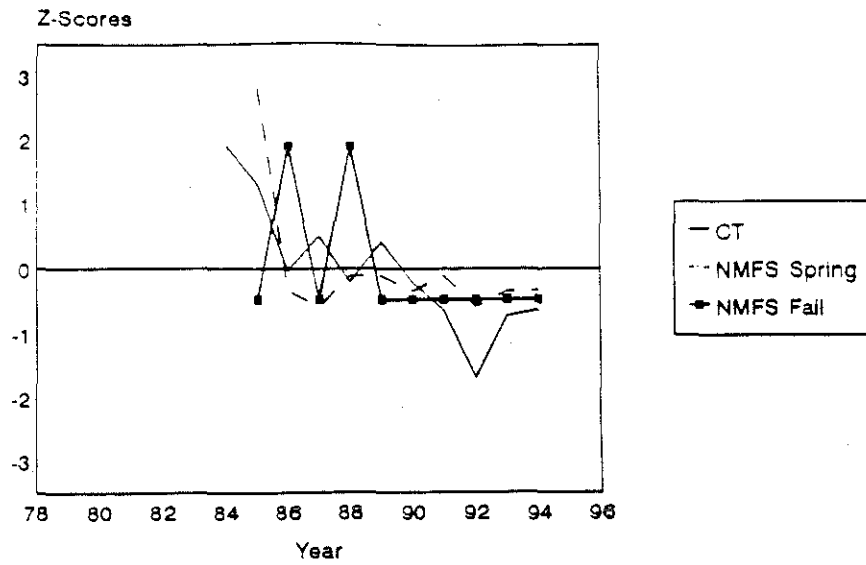


Figure 8. Standardized age seven winter flounder survey indices for Connecticut, NMFS spring and fall, Rhode Island and Massachusetts.

Age Eight Indices
Z-scores

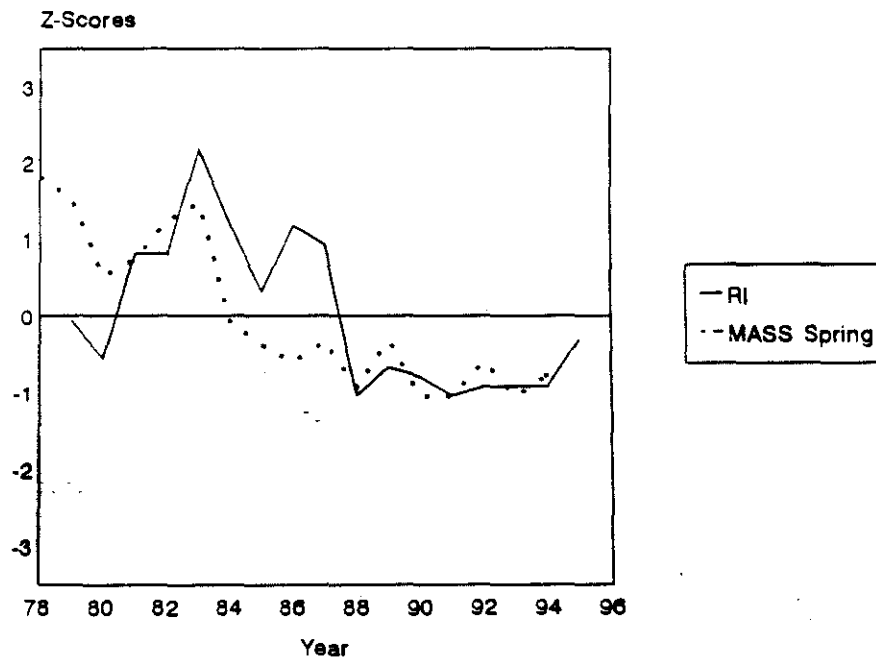
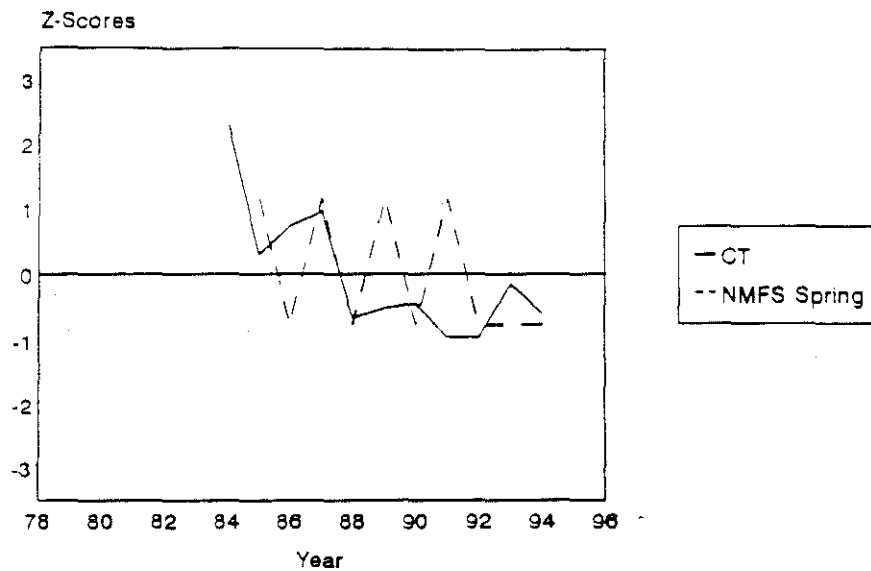


Figure 9. Standardized age eight winter flounder survey indices for Connecticut, NMFS spring, Rhode Island and Massachusetts.

Age Nine Indices Z-scores

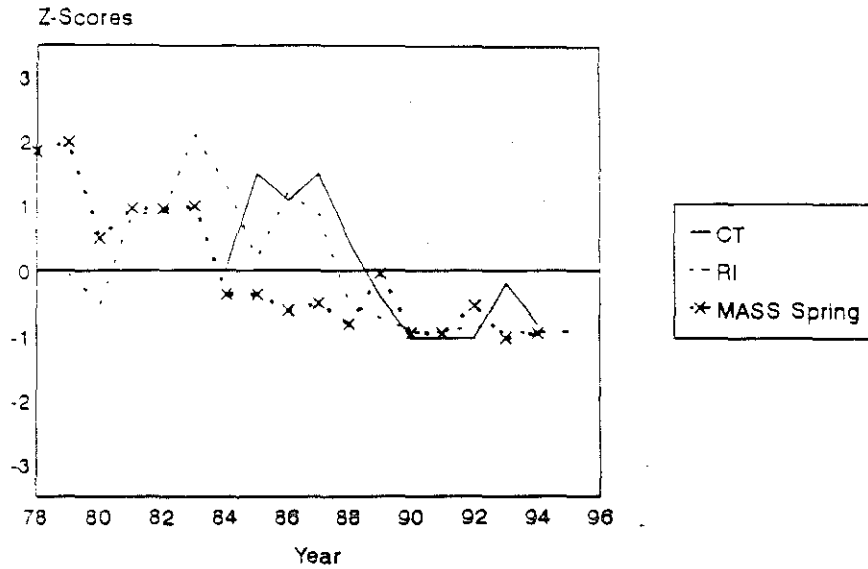


Figure 10. Standardized age nine winter flounder survey indices for Connecticut, Rhode Island and Massachusetts.

Age Ten Indices Z-scores

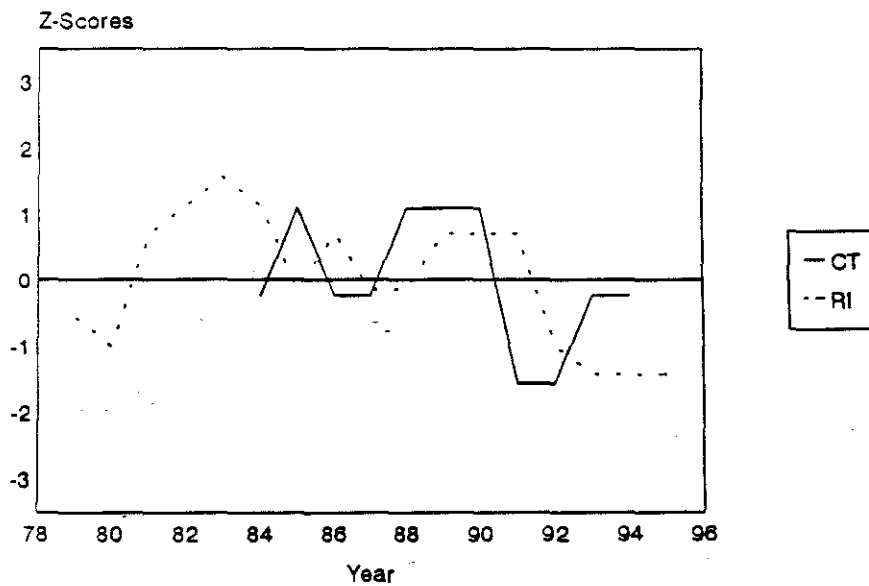


Figure 11. Standardized age ten winter flounder survey indices for Connecticut and Rhode Island.

CT Winter Flounder Survey
Transformed Z scores by age group

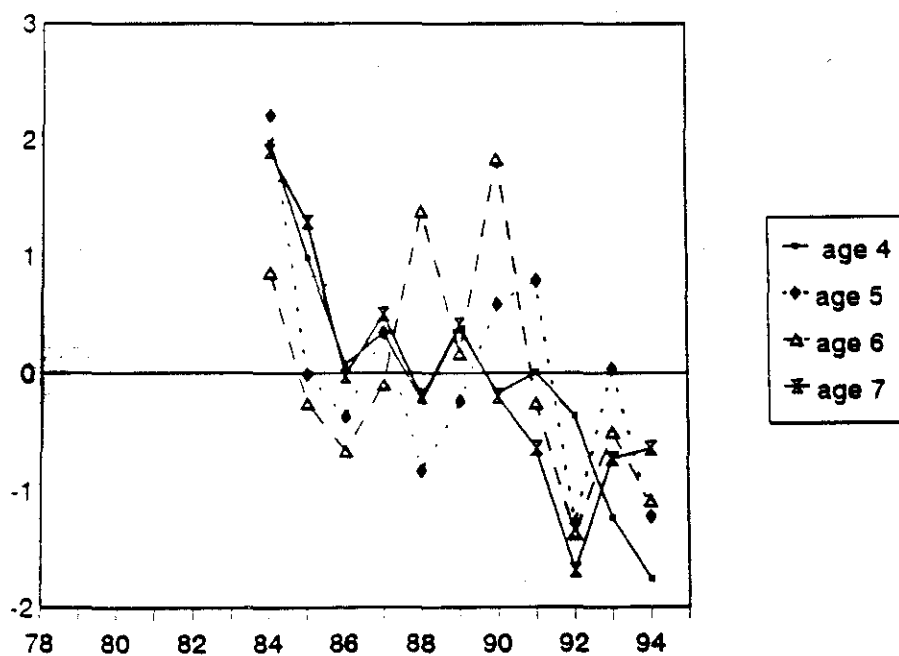
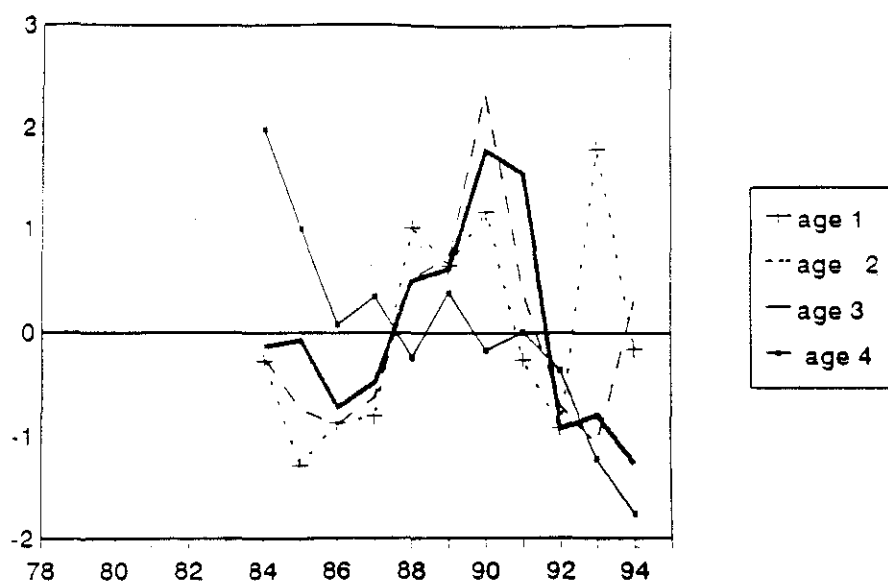


Figure 12. Standardized winter flounder survey indices by age group from Connecticut survey.

RIDFW Winter Flounder Survey
Transformed Z scores by age group

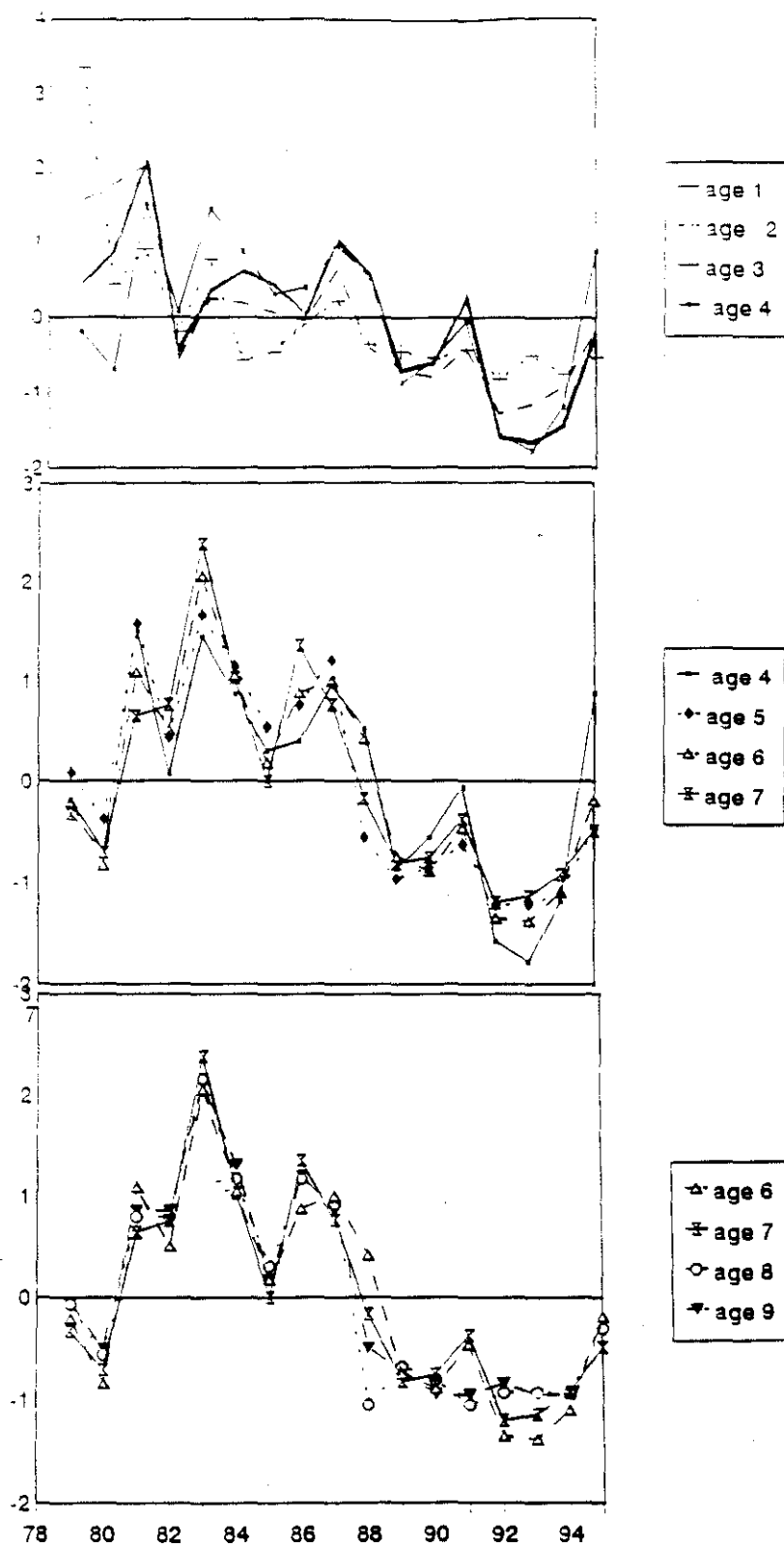


Figure 13. Standardized winter flounder survey indices by age group from Rhode Island survey.

NMFS spring flounder Survey
Transformed Z scores by age group

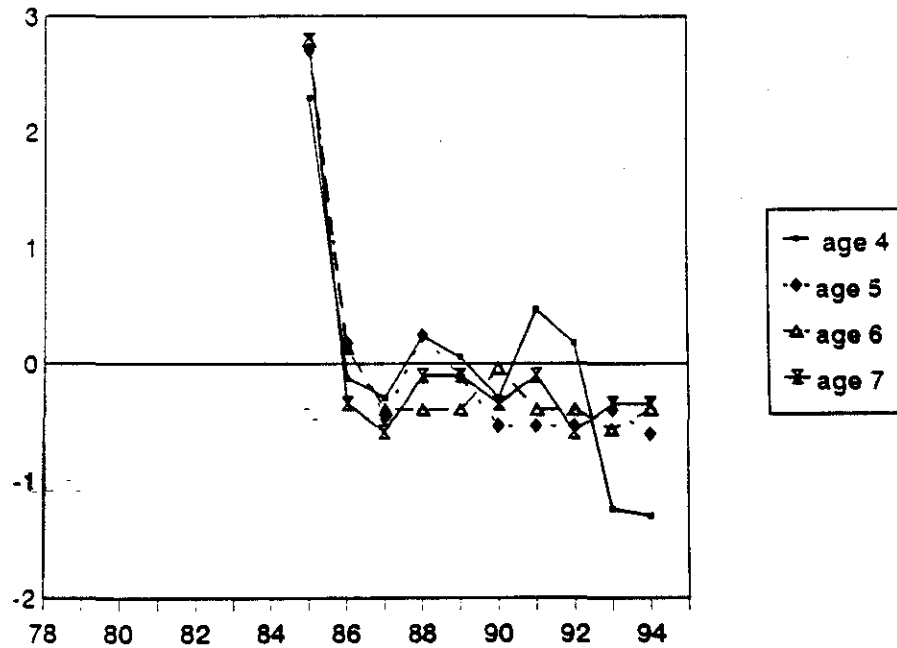
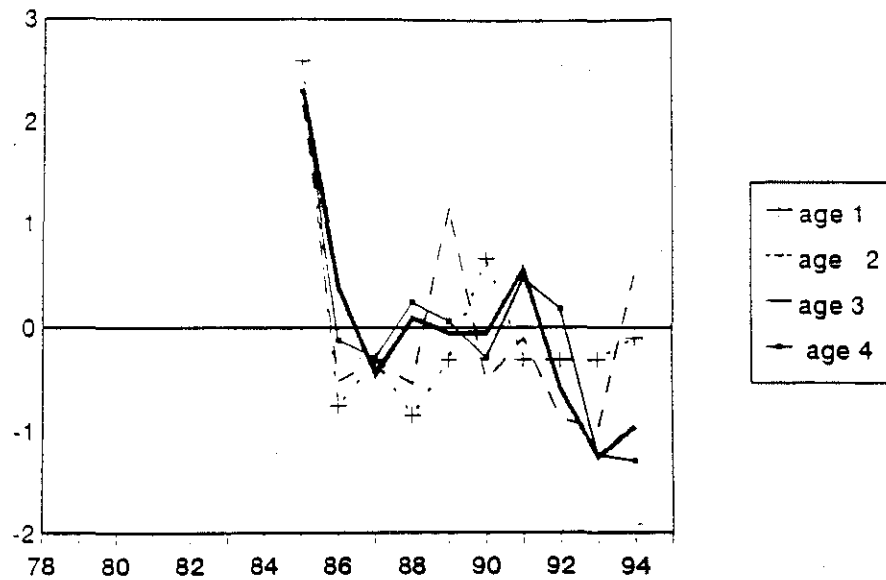


Figure 14. Standardized winter flounder survey indices by age group from NMFS spring survey.

NMFS fall flounder Survey
Transformed Z scores by age group

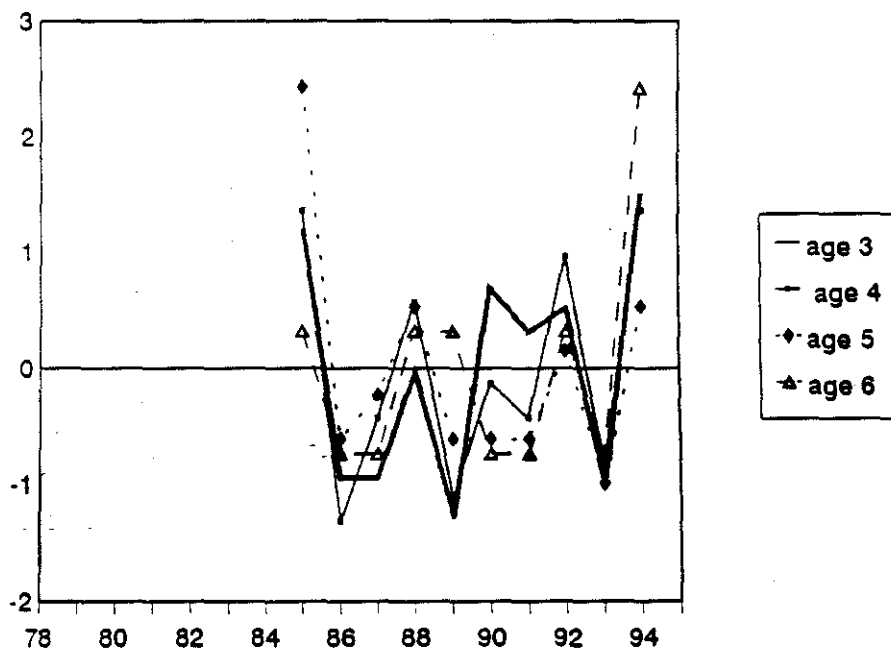
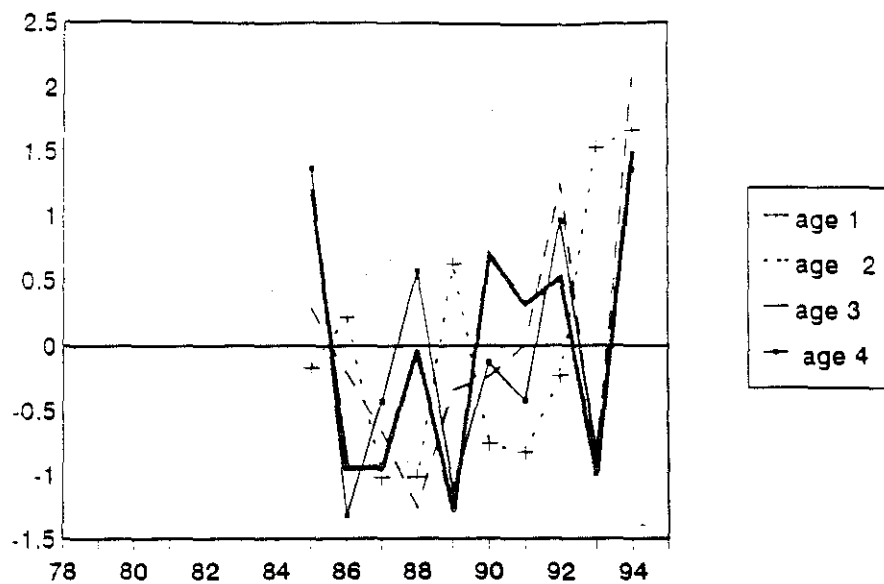


Figure 15. Standardized winter flounder survey indices by age group from NMFS fall survey.

Mass Winter Flounder Survey
Transformed Z scores by age group

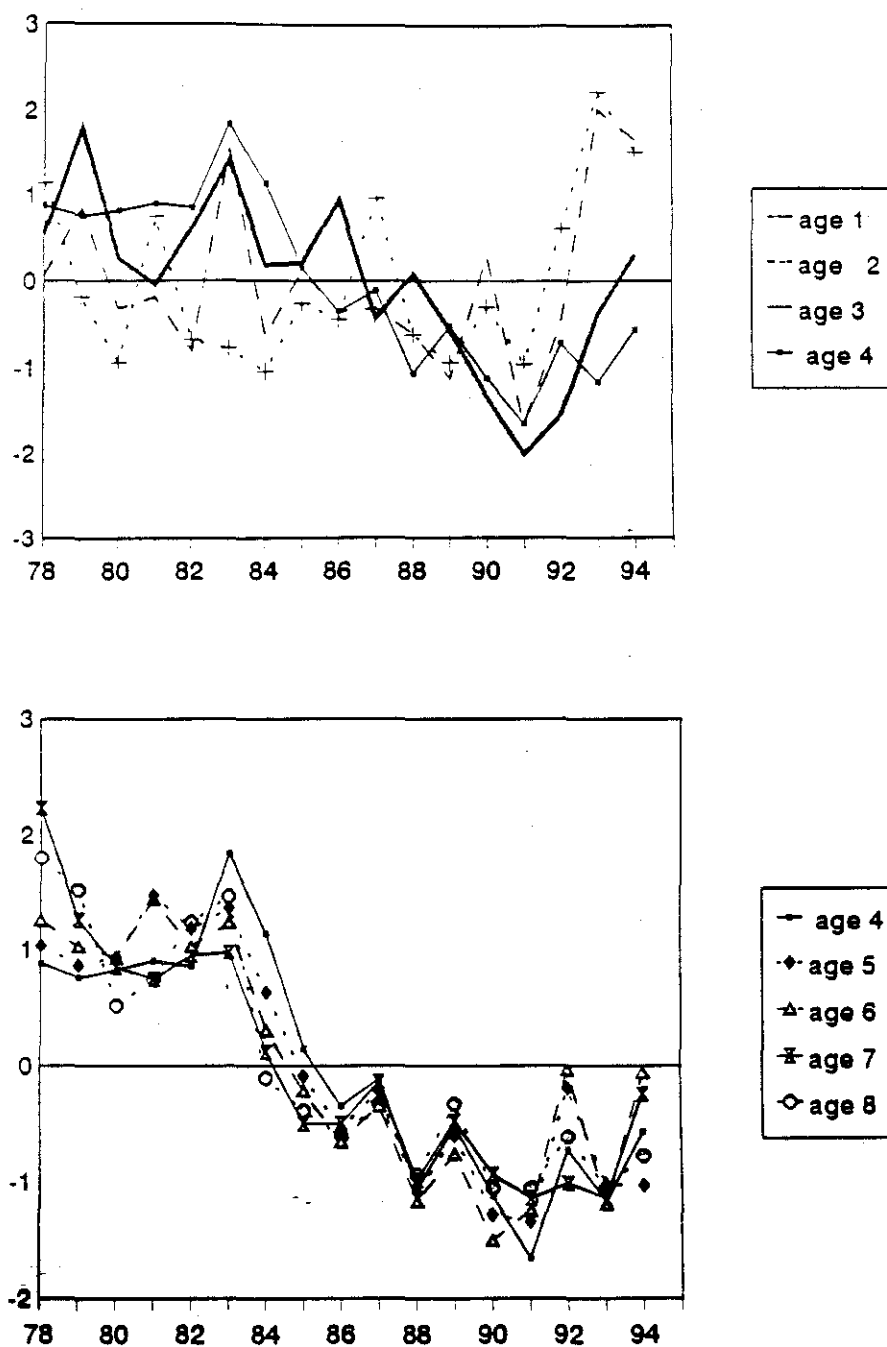


Figure 16. Standardized winter flounder survey indices by age group from Massachusetts survey.

Appendix IV. Summary of Winter Flounder Tag Return Studies,
Southern New England - Mid-Atlantic Region

M. Gibson
RI Division of Fish and Wildlife
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Table 1- Winter Flounder Tag Returns by Area for Several Tagging Studies in the Southern New England Region. Tag Recovery Zones Refer to Those of Perlmutter (1947). References for the Data Source are Also Given.

<u>Tag Site</u>	<u>Tag Zone</u>	<u>Number Tagged</u>	<u>Return Zone</u>	<u>Number Tags</u>	<u>%</u>	<u>Reference</u>
Great S. Bay	2	2013	1	1	0.2	(1)
			2	518	95.6	
			3	5	0.9	
			4	2	0.4	
			5	10	1.8	
			6	0	0	
			7	6	1.1	
			8	0	0	
			9	0	0	
Shinnecock Bay	2	319	1	0	0	(1)
			2	62	91.2	
			3	0	0	
			4	2	2.9	
			5	4	5.9	
			6	0	0	
			7	0	0	
			8	0	0	
			9	0	0	
Matinicock Pt.	4	564	1	0	0	(1)
			2	0	0	
			3	0	0	
			4	128	96.2	
			5	3	2.3	
			6	1	0.7	
			7	1	0.8	
			8	0	0	
Port Jefferson	4	532	1	0	0	(1)
			2	3	2.5	
			3	0	0	
			4	89	73.9	
			5	28	23.1	
			6	1	0.8	
			7	0	0	
			8	0	0	
			9	0	0	

Table 1- Continued

<u>Tag Site</u>	<u>Tag Zone</u>	<u>Number Tagged</u>	<u>Return Zone</u>	<u>Number Tags</u>	<u>%</u>	<u>Reference</u>
Grt. Peconic Bay	5	202	1	0	0	(1)
			2	0	0	
			3	0	0	
			4	1	1.0	
			5	93	98.0	
			6	1	1.0	
			7	0	0	
			8	0	0	
			9	0	0	
Gardiners Bay	5	480	1	0	0	(1)
			2	0	0	
			3	0	0	
			4	9	11.3	
			5	70	87.5	
			6	0	0	
			7	1	1.2	
			8	0	0	
			9	0	0	
Mystic River	5	632	1	0	0	(1)
			2	0	0	
			3	0	0	
			4	2	1.8	
			5	105	92.1	
			6	3	2.6	
			7	4	3.5	
			8	0	0	
			9	0	0	
Watch Hill/Quono	5	307	1	0	0	(1)
			2	0	0	
			3	0	0	
			4	1	2.0	
			5	38	74.5	
			6	6	11.7	
			7	6	11.8	
			8	0	0	
			9	0	0	

Table 1- Continued

<u>Tag Site</u>	<u>Tag Zone</u>	<u>Number Tagged</u>	<u>Return Zone</u>	<u>Number Tags</u>	<u>%</u>	<u>Reference</u>
Block Island	5	115	1	0	0	(1)
			2	0	0	
			3	0	0	
			4	0	0	
			5	1	14.3	
			6	1	14.3	
			7	5	71.4	
			8	0	0	
			9	0	0	
Block Isld Snd	5	675	1	0	0	(1)
			2	1	3.0	
			3	0	0	
			4	3	9.2	
			5	20	60.6	
			6	4	12.1	
			7	4	12.1	
			8	1	3.0	
			9	0	0	
Pt. Judith Pond	5	279	1	0	0	(1)
			2	0	0	
			3	0	0	
			4	0	0	
			5	79	90.8	
			6	7	8.0	
			7	1	1.2	
			8	0	0	
			9	0	0	
RI Sound	6	263	1	0	0	(1)
			2	0	0	
			3	0	0	
			4	1	5.6	
			5	4	22.2	
			6	8	44.4	
			7	5	27.8	
			8	0	0	
			9	0	0	

Table 1- Continued

<u>Tag Site</u>	<u>Tag Zone</u>	<u>Number Tagged</u>	<u>Return Zone</u>	<u>Number Tags</u>	<u>%</u>	<u>Reference</u>
Narragansett Bay	6	980	1	0	0	(1)
			2	0	0	
			3	0	0	
			4	0	0	
			5	3	2.2	
			6	135	97.1	
			7	1	0.7	
			8	0	0	
			9	0	0	
Woods Hole	7	4171	1	0	0	(1)
			2	4	1.7	
			3	0	0	
			4	3	1.3	
			5	0	0	
			6	3	1.2	
			7	227	94.4	
			8	2	0.8	
			9	0	0.4	
Nantucket Shoal	7	494	1	0	0	(1)
			2	0	0	
			3	0	0	
			4	0	0	
			5	0	0	
			6	0	0	
			7	45	97.8	
			8	1	2.2	
			9	0	0	
Charlestown Pnd	5	952	1	0	0	(2)
			2	0	0	
			3	0	0	
			4	0	0	
			5	134	94.4	
			6	6	4.2	
			7	2	1.4	
			8	0	0	
			9	0	0	

Table 1- Continued

<u>Tag Site</u>	<u>Tag Zone</u>	<u>Number Tagged</u>	<u>Return Zone</u>	<u>Number Tags</u>	<u>%</u>	<u>Reference</u>
Narragansett Bay	6	980	1	0	0	(3)
			2	0	0	
			3	0	0	
			4	0	0	
			5	0	0	
			6	310	96.0	
			7	13	4.0	
			8	0	0	
			9	0	0	
Great S. Bay	2	2993	1	0	0	(4)
			2	845	100.0	
			3	0	0	
			4	0	0	
			5	0	0	
			6	0	0	
			7	0	0	
			8	0	0	
			9	0	0	
Buzzards Bay	7	336	1	0	0	(5)
			2	0	0	
			3	0	0	
			4	0	0	
			5	1	1.6	
			6	17	26.6	
			7	40	62.4	
			8	6	9.4	
			9	0	0	
Tarpaulin Cove	7	500	1	0	0	(5)
			2	0	0	
			3	0	0	
			4	0	0	
			5	6	4.5	
			6	27	20.5	
			7	95	72.0	
			8	4	3.0	
			9	0	0	

Table 1- Continued

<u>Tag Site</u>	<u>Tag Zone</u>	<u>Number Tagged</u>	<u>Return Zone</u>	<u>Number Tags</u>	<u>%</u>	<u>Reference</u>
Miacomet Rip	7	440	1	0	0	(5)
			2	0	0	
			3	0	0	
			4	0	0	
			5	0	0	
			6	1	0.8	
			7	127	97.7	
			8	2	1.5	
			9	0	0	
Rodgers Shoal	7	500	1	0	0	(5)
			2	0	0	
			3	0	0	
			4	0	0	
			5	0	0	
			6	1	0.4	
			7	226	91.9	
			8	19	7.7	
			9	0	0	
Nantucket Shoal	7	326	1	0	0	(5)
			2	0	0	
			3	0	0	
			4	0	0	
			5	0	0	
			6	0	0	
			7	123	100.0	
			8	0	0	
			9	0	0	
Provincetown	8	318	1	0	0	(5)
			2	0	0	
			3	0	0	
			4	0	0	
			5	0	0	
			6	0	0	
			7	10	9.3	
			8	98	90.7	
			9	0	0	

Table 1- Continued

<u>Tag Site</u>	<u>Tag Zone</u>	<u>Number Tagged</u>	<u>Return Zone</u>	<u>Number Tags</u>	<u>%</u>	<u>Reference</u>
Georges Bank	9	250	1	0	0	(5)
			2	0	0	
			3	0	0	
			4	0	0	
			5	0	0	
			6	0	0	
			7	1	0.9	
			8	0	0	
			9	108	99.1	
Niantic River	5	4978	1	0	0	(6)
			2	0	0	
			3	0	0	
			4	64	5.3	
			5	1065	88.9	
			6	55	4.6	
			7	12	1.0	
			8	0	0	
			9	2	0.2	
Narragansett Bay	6	6128	1	0	0	(7)
			2	0	0	
			3	0	0	
			4	0	0	
			5	5	0.6	
			6	781	97.5	
			7	13	1.6	
			8	0	0	
			9	2	0.3	

Table 1- Continued

<u>Tag Site</u>	<u>Tag Zone</u>	<u>Number Tagged</u>	<u>Return Zone</u>	<u>Number Tags</u>	<u>%</u>	<u>Reference</u>
Pt.Judith Pd.	5	NA	1	0	0	(8)
			2	0	0	
			3	0	0	
			4	1	1.2	
			5	62	75.6	
			6	19	18.3	
			7	4	4.9	
			8	0	0	
			9	0	0	
Narrag. Bay	6	995	1	0	0	(9)
			2	0	0	
			3	0	0	
			4	0	0	
			5	0	0	
			6	162	97.0	
			7	5	3.0	
			8	0	0	
			9	0	0	

- References-
- (1) Perlmutter 1947
 - (2) Saila 1961
 - (3) Saila 1962
 - (4) Poole 1969
 - (5) Howe and Coates 1975
 - (6) NUSCo. 1987
 - (7) Powell 1989
 - (8) Crawford 1990
 - (9) Black et al. 1988

Table 2- Transition Probability Matrix for Winter Flounder Tagged in Various Locations in Southern New England. Zones Refer to Those of Perlmutter (1947)

Recovery Zone	Tagging Zone								
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>
1	0	0.2	0	0	0	0	0	0	0
2	0	92.5	0	2.5	2.8	0	1.7	0	0
3	0	0.9	0	0	0	0	0	0	0
4	0	1.6	0	83.0	4.1	5.2	1.4	0	0
5	0	3.8	0	12.8	71.3	7.7	1.7	0	0
6	0	0	0	0.8	7.8	80.0	7.1	0	0
7	0	1.1	0	0.8	11.1	6.9	83.9	9.3	0.9
8	0	0	0	0	2.8	0	4.3	90.7	0
9	0	0	0	0	0.2	0.3	0	0	90.1

Table 3- Percent Composition, Classified by Tagging Location, of Tagged Flounder Recaptured in Zone Number 5 from Perlmutter's 1947 Study. Percent Composition has been Adjusted to Reflect Release Number.

<u>Tagging Location</u>	Percent Composition		
	<u>Spring</u>	<u>Fall</u>	<u>All</u>
Nantucket Shoals	0	0	0
Woods Hole	0	0	0
Narr./Mt. Hope Bay	0.67	1.14	0.77
RI Sound	1.51	0	1.15
Block Island	0	2.80	0.66
Pt. Judith Pond	18.40	31.60	21.38
Block Island Sound	1.34	4.80	2.24
Watch Hill/Quonochontaug	9.82	8.50	9.35
Mystic River	11.92	9.85	12.35
Gardiners Bay	10.26	14.27	11.00
Peconic Bay	42.78	12.90	35.13
Port Jefferson, LIS	2.27	9.81	4.00
Matinicock Point, LIS	0.20	1.30	0.45
Shinnecock Bay	0.63	2.05	0.94
Great South Bay	0.20	0.98	0.38

Table 4- Percent Composition, Classified by Tagging Location, of Tagged Flounder Recaptured in Zone Number 6 from Perlmutter's 1947 Study. Percent Composition has been Adjusted to Reflect Release Number.

<u>Tagging Location</u>	Percent Composition		
	<u>Spring</u>	<u>Fall</u>	<u>All</u>
Nantucket Shoals	0	0	0
Woods Hole	0.68	0	0.31
Narr./Mt. Hope Bay	61.66	49.30	57.20
RI Sound	14.14	11.90	12.40
Block Island	0	6.90	3.60
Pt. Judith Pond	10.40	11.40	10.36
Block Island Sound	1.40	3.50	2.50
Watch Hill/Quonochontaug	9.10	7.80	8.10
Mystic River	2.98	1.30	1.90
Gardiners Bay	0	0	0
Peconic Bay	0	4.00	2.10
Port Jefferson, LIS	0	1.40	0.70
Matinicock Point, LIS	0	2.50	0.83
Shinnecock Bay	0	0	0
Great South Bay	0	0	0

Table 5- Percent Composition, Classified by Tagging Location, of Tagged Flounder Recaptured in Zone Number 4 from Perlmutter's 1947 Study. Percent Composition has been Adjusted to Reflect Release Number.

<u>Tagging Location</u>	<u>Percent Composition</u>		
	<u>Spring</u>	<u>Fall</u>	<u>All</u>
Nantucket Shoals	0	0	0
Woods Hole	0.06	0	0.03
Narr./Mt. Hope Bay	0.00	0.00	0.00
RI Sound	1.00	0.00	0.50
Block Island	0.00	0.00	0.00
Pt. Judith Pond	0.00	0.00	0.00
Block Island Sound	1.13	0.00	0.56
Watch Hill/Quonochontaug	0.85	0.00	0.42
Mystic River	0.82	0.00	0.41
Gardiners Bay	4.29	3.40	3.85
Peconic Bay	1.28	0.00	0.64
Port Jefferson, LIS	31.67	37.70	34.69
Matinicock Point, LIS	58.00	52.27	55.14
Shinnecock Bay	0.80	0.50	0.65
Great South Bay	1.30	0.81	1.06

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